

SEQUENCE LISTING

SEQ ID NO: 1 amino acid sequence comprising GAS 40

MDLEQTKPNQVKQKIALTSTIALLSASVGVSHQVKADDRASGETKASNTHDDSLPKPETIQEAKATIDAVE
KTLSQQKAELTELATALTKTTAEINHLKEQQDNEQKAL TSAQEIYTNNTLASSEETLLAQGAHQRELTATE
TELHNAQADQHSKETALSEQKASISAETTRAQDLVEQVKTSEQNIAKLNAMI SNPDAITKAAQTANDNTKA
LSSELEKAKADLENQKAKVKKQLTEELAAQKAALAEKEAELSRLKSSAPSTQDSIVGNNTMKAPQGYPLEE
LKKLEASGYIGSASYNYYKEHADQIIAKASPGNQLNQYQDIPADRNRFDVDPDNLTPEVQNELAQFAHMI
NSVRRQLGLPPVTVTAGSQEFARLLSTS YKKTGHNTRPSFVYGQPGVSGHYGVGPHDKTIIEDSAGASGLI
RNDDNMYENIGAFNDVHTVNGIKRGIYDSIKYMLFTDHLHGNTYGHAINFLRVDKHNPNAPVYLGFTSNV
GSLNEHFVMPFESNIANHQRFNKTPIKAVGSTKDYAQRVGTVSDTIAAIKGVSSLENRLSAIHQEADIMA
AQAKVSQLQGLASTLQSDSLNLQVRQLNDTKGSLRTELLAAKAKQAQLEATRDQSLAKLASLKAALHOT
EALAEQAAARVTALVAKKAHLQYLRDFKLNPNRLQVIRERIDNTKQDLAKTSSLLNAQEAALQAKQSS
LEATLATEHQLTLKTLANEKEYRHLDEDIATVPDLQVAPPLTGVKPLSYSKIDTTPLVQEMVKETKQLL
EASARLAAENTSLVAEALVGQTSEMVASNAIVSKITSSITQPSKTSYSGSSTTSNLISDVDESTQRALK
AGVVMLAAVGLTGFRFRKESK

SEQ ID NO: 2 polynucleotide sequence encoding for GAS 40

ATGGACTTAGAACAAACGAAACCAACCAAGTTAAGCAGAAAATTGCTTTAACCTCAACAATTGCTTTTATT
GAGTGCAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAAACGAAGGCGAGTA
ATACTCACGACGATAGTTTACCAAACAGAAACAATCAAGAGGCAAAGGCAACTATTGATGCAGTTGAA
AAAACCTCTCAGTCAACAAAAGCAGAAGCTGACAGAGCTTGC TACCGCTCTGCACAAAACACTACTGCTGAAAT
CAACCACCTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAAGAAATTTACACATA
CTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAA
ACAGAGCTTCATAATGCTCAAGCAGATCAACATTTCAAAGAGACTGCATTGTG CAGAACAAAAGCTAGCAT
TTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACCGTCTGAACAAAATATTGCTAAGC
TCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCA
TTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAAAAGCAATTGAC
TGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAGAGGCAGAAGCTTAGTCGCTTAAATCCTCAG
CTCCGCTACTCAAGTAGCATTTGTGGTGAATAATACCATGAAAGCACC GCAAGGCTATCCTCTTGAAGAA
CTTAAAATAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGTGACA
TCAAATTTATTGCCAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGATATTTCCAGCATCGTACAT
GCTTTGTGTTGATCCCATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATT
AATAGTGTAAGAAGACAATTAGGCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATT
ACTTAGTACCAGCTATAAGAAAACTCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTAT
CAGGGCATTATGGTGTGGGCCCTCATGATAAAACTATTTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATT
CGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACTGTGAATGGTATTAAACG
TGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAAATACATACGGCCATGCTA
TTAACTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATGTA
GGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGCTAACATTGCTAACCATCAACGCTTTAATAAGAC
CCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGCGA
CGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTPTTGTCGGCTATTTCATCAAGAAGCTGATATTATGGCA
GCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCT
CCAAGTGAGACAATTAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACAAG
CACAACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCAC TGCACCAGACA
GAAGCCTTAGCAGAGCAAGCCGCAGCCAGAGTGACAGCACTGGTGGCTAAAAAGCTCATTTGCAATATCT
AAGGGACTTTAAATGAAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTTGATAATAC TAAGCAAGATT
TGGCTAAAACACTACCTCATCTTTGTAAATGCCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGT
CTAGAAGCTACTATTGCTACCACAGAACACAGGTTGACTTTGCTTAAAACCTTAGCTAACGAAAAGGAATA
TCGCCACTTAGACGAAGATATAGCTACTGTGCGCTGATTTGCAAGTAGCTCCACCTTACGGGCGTAAAC
CGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTC AAGAAATGGTTAAAAGAAACGAAACAACATTA
GAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGA
AATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTAGCCCTCATCTAAGACATCTT
ATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAAAGAGCTCTTAAA
GCAGGAGTCGTCATGTTGGCAGCTGTCGGCCTCACAGGATTTAGGTTCCGTAAGGAATCTAAGTGA

SEQ ID NO: 3 amino acid sequence comprising an N terminal leader sequence of GAS 40

MDLEQTKPNQVKQKIALTSTIALLSA

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SEQ ID NO: 4 polynucleotide sequence encoding an N terminal leader sequence of GAS 40
 ATGGACTTAGAACAAACGAAGCCAAACCAAGTTAAGCAGAAAATTGCTTTAACCTCAACAATTGCTTTATT
 GAGTGCC

SEQ ID NO: 5 amino acid sequence comprising a fragment of GAS 40 with N terminal leader
 sequence removed

SVGVSHQVKADDRASGETKASNTHDDSLPKPETIQEAKATIDAVEKTLSSQKAELELATALTKTTAEINH
 LKEQQDNEQKALTSAQEIYTNLASEETLLAQGAHQRELTATETELHNAQADQHSKETALSEQKASISA
 ETTRAQDLVEQVKTSEQNIAKLNAMISNPDAITKAAQTANDNTKALSSELEKAKADLENQKAKVKKQLTEE
 LAAQKAALAEKEAELSRLLKSSAPSTQDSIVGNNTMKAPQGYPLEELKKLEASGYIGSASYNYYKEHADQI
 IAKASPGNQLNQYQDIPADRNRFVDEPNLTPEVQNELAQFAAHMINSVRRQLGLPPVTVTAGSQEFARLLS
 TSYKKTGHNTRPSFVYQPGVSGHYGVGPHDKTIIEDSAGASGLIRNDDNMYENIGAFNDVHTVNGIKRGI
 YDSIKYMLFTDHLHGNTYGHAINFLRVDKHNPNAPVYLGFTSNVGLSNEHFVMFPESNIANHQRFNKTP
 KAVGSTKDYAQRVGTVSDTIAAIKGVSSLENRLSAIHQEADIMAAQKVSQLOGKLASTLKQSDSLNLQV
 RQLNDTKGSLRTELLAAKAKQAQLEATRDQSLAKLASLKAALHQTEALAEQAAARVTALVAKKAHLQYLRD
 FKLNPNRQLQVIRERIDNTKQDLAKTTSSLLNAQEALALQAKQSSLEATIATTEHQTLTKLANEKEYRH
 LDEDIATVPDLQVAPPLTGVKPLSYSKIDTTPLVQEMVKETKOLLEASARLAAENTSLVAEALVGQTS
 EMV
 ASNAIVSKITSSITQPSSKTSYSGSGSSTSNLISDVDESTQRALKAGVVMLAAVGLTGFRFRKESK

SEQ ID NO: 6 polynucleotide sequence encoding a fragment of GAS 40 with N terminal leader
 sequence removed

AGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATACTCA
 CGACGATAGTTTACCAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAAATC
 TCAGTCAACAAAAAGCAGAAGTACAGAGCTTGCACCGCTCTGACAAAACTACTGCTGAAATCAACCAC
 TAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCTTGC
 AAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAGAGC
 TTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTCAGAACAAAAGCTAGCATTTCAGCA
 GAAACTACTCGAGCTCAAGATTTAGTGGAAACAGTCAAACAGTCTGAACAAAATATGCTAAGCTCAATGC
 TATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCAGCT
 CAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAAAAAGCAATTGACTGAAGAG
 TTGGCAGCTCAGAAAAGCTGCTTAGCAGAAAAGAGGCAGAAGCTTAGTCGTCTTAAATCCTCAGCTCCGTC
 TACTCAAGATAGCATTTGTTGGTAATAATACCATGAAAGCACCAGGCTATCCTCTTGAAGAACTTAAAA
 AATTAGAAGCTAGTGGTTATATGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGATCAAATT
 ATTGCCAAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGATATTCCAGCAGATCGTAATCGCTTTGT
 TGATCCCATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATAGTG
 TAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATTACTTAGT
 ACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTATCAGGCA
 TTATGGTGTGGGCCCTCATGATAAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATTCGAAATG
 ATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACTGTGAATGGTATTAACGTTGGTATT
 TATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTATTAAGTT
 TTTACGTGTAGATAAACATAACCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGATCTT
 TGAATGAACACTTTGTAATGTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGACCCCTATA
 AAAGCCGTGGAAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGCGAGGATCAA
 AGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGGCTATTATCAAGAAGCTGATATTATGGCAGCCCAAG
 CTAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTAAGCAGTCAAGCAGCTTAAATCTCCAAGTG
 AGACAATTAATGATACTAAAGGTTCTTTGAGAACAGAATTAAGCAGCTAAGCAGCTAAGCAGCTAAGCAGCT
 CGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAAGCCGCACTGCACCAGACAGAAGCCT
 TAGCAGAGCAAGCCGACAGCAGAGTGACAGCAGCTGGTGGCTAAAAAGCTCATTTGCAATATCTAAGGGAC
 TTTAAATGAAATCTTCAAGTATGATGATGATGATGATGATGATGATGATGATGATGATGATGATGATGATGAT
 AACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGTCTAGAAG
 CTACTATTGCTACCACAGAACCAGTTGACTTTGCTTAAAACCTTAGCTAACGAAAAGGAATATCGCCAC
 TTAGACGAAGATATAGCTACTGTGCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAAACCGCTATC
 ATATAGTAAGATAGATACTACCTCGCTTGTTCAGAAATGGTTAAAGAAAACGAAACAATATTAGAAGCTT
 CAGCAAGATTAGCTGCTGAAAATACAAGCTTTGTAGCAGAAAGCCTTGTGGCCAAACCTCTGAAATGGTA
 GCAAGTAATGCCATGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTTATGGCTC

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AGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAAAGAGCTCTTAAAGCAGGAG
TCGTCATGTTGGCAGCTGTCGGCCTCACAGGATTTAGGTTCCGTAAGGAATCTAAGTGA

SEQ ID NO: 7 amino acid sequence comprising a C terminal transmembrane region of GAS 40
ALKAGVVMLAAVGLTGFRRKESK

SEQ ID NO: 8 polynucleotide sequence encoding a C terminal transmembrane region of GAS 40
GCTCTTAAAGCAGGAGTCGTCATGTTGGCAGCTGTCGGCCTCACAGGATTTAGGTTCCGTAAGGAATCTAA
GTGA

SEQ ID NO: 9 amino acid sequence comprising a fragment of GAS 40 with a C terminal
transmembrane sequence removed

MDLEQTKPNQVKQKIALTSTIALLSASVGVSHQVKADDRASGETKASNTHDDSLPKPETIQEAKATIDAVE
KTLSSQKAELELATALTKTTAEINHLKEQQDNEQKAL TSAQEIYTNTLASSEETLLAQGAHQREL TATE
TELHNAQADQHSKETALSEQKASI SAETTRAQDLVEQVKTSEQNIAKLNAMISNPDAITKAAQTANDNTKA
LSSELEKAKADLENQKAKVKKQLTEELAAQKALAEKEAEL SRLKSSAPSTQDSIVGNNTMKAPQGY PLEE
LKKLEASGYIGSASYN NYKEHADQI IAKASPGNQLNQYQDI PADRNRFVDPDNLTP EVQNELAQFAHMI
NSVRRQLGLPPVTVTAGSQEFARLLSTSYKKTHGNTRPSFVYGQPGVSGHYGVGPHDKTII IEDSAGASGLI
RNDDNMYENIGAFNDVHTVNGIKRGIYDSIKYMLF'DHLHGNTYGHAINFLRVDKHNPNAPVYLG FSTSNV
GSLNEHFVMFPESNIANHQRFNKTPIKAVGSTKDYAQRVGTVSDTIAAIKGVSSLENRLSAIHQEADIMA
AQAKVSQQLQKLASTLKQSDSLNLQVRQLNDTKGSLRTELLAAKAKQAQLEATRDQSLAKLASLQKAAALHQ
EALAEQAAARVTALVAKKAHLQYLRDFKLNPNRLQVIRERIDNTKQDLAKTSSLLNAQEALALQAKQSS
LEATITATTEHQTLTLKLANEKEYRHLDEDIATVPDLQVAPPLTGVKPLSYSKIDTTPLVQEMVKETKQLL
EASARLAAENTSLVAEALVGQTSSEMVASNAIVSKITSSITQPSKTSYSGSGSSTTNSLISDVDESTQR

SEQ ID NO: 10 polynucleotide sequence encoding a fragment of GAS 40 with a C terminal
transmembrane sequence removed

ATGGACTTAGAACAAACGAAGCCAAACCAAGTTAAGCAGAAAATTGCTTTAACCTCAACAATTGCTTTATT
GAGTGCCAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTA
ATACTCACGACGATAGTTTACCAAAACCAGAAACAATTCAAGAGGCCAAAGGCAACTATTGATGCAGTGA
AAAACCTCTCAGTCAACAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAAACTACTGTA
CAACCACTTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATA
CTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAA
ACAGAGCTTCATAATGCTCAAGCAGATCAACATTTCAAAGAGACTGCATTGTCAGAACAAAAGCTAGCAT
TTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAAACAAAGTCAAACGCTCTGAACAAAATATTGCTAAGC
TCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCA
TTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAAAAGCAATTGAC
TGAAGAGTTGGCAGCTCAGAAAAGCTGCTTAGCAGAAAAAGAGGCAGAACTTAGTCGCTTAAATCCTCAG
CTCCGCTTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCAGCAAGGCTATCCTCTTGAAGAA
CTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGACAGA
TCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCAGCAGATCGTAATC
GCTTTGTTGATCCCATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATT
AATAGTGTAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAGAATTTGCAAGATT
ACTTAGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATCAATTTGCTTACGGACAGCCAGGGGTAT
CAGGGCATTATGGTGTGGGCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATT
CGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACTGTGAATGGTATTAACG
TGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTA
TTAACTTTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATGTA
GGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGAC
CCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCCTGTATCTGATACTATTGCAG
CGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTTCATCAAGAAGCTGATATTATGGCA
GCCAAGCTAAAGTAAGTCAACTTCAAGGTAATTTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCT
CCAAGTGAGACAATTAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAAACAAG
CACAACTCGAAGCTACTCGTCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGACTGCACCAGACA
GAAGCCTTAGCAGAGCAAGCCGACGACAGCAGCATGGTGGCTAAAAAGCTCATTGCAATATCT
AAGGGACTTTAAATTGAATCCTAACCCCTTCAAGTGATACCTGAGCGCATTGATAATACTAAGCAAGATT

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TGGCTAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGT
CTAGAAGCTACTATTGCTACCCACAGAACACCAGTTGACTTTGCTTAAAACCTTAGCTAACGAAAAGGAATA
TCGCCACTTAGACGAAGATATAGCTACTGTGCCGTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAAC
CGCTATCATATAGTAAGATAGATACTACTCCGC'TTGTTCAGAAATGGTTAAAGAAACGAAACAACCTATTA
GAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGA
AATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTT
ATGGCTCAGGATCTTCTACAACGAGCAATCTCATTCTGATGTTGATGAAAGTACTCAAAGA

SEQ ID NO: 11 amino acid sequence comprising a transmembrane region of GAS 40 as shown in Figures 1 and 2. ALKAGVVMLAAVGLTG

SEQ ID NO: 12 amino acid sequence comprising a first coiled-coil region of GAS 40
ETIQEAKATIDAVEKTLSSQKAELELATALTKTTAEINHLKEQQDNEQKAL TSAQEIYTNLSSSEETLL
AQGAHQRELTATETELHNAQADQHSKETALSEQKASISAETTRAQDLVEQVKTSEQNIAKLNAMISNPDA
ITKAAQTANDNTKALSSELEKAKADLENQKAKVKKQLTEELAAQKAALAEKEAELSRLKSSA

SEQ ID NO: 13 amino acid sequence comprising a second coiled-coil region of GAS 40
RLSAIHQEADIMAAQAKVSQLQGKLASTLTKQSDSLNLQVRQLNDTKGSLRTELLAAKAKQAQLEATRDQSL
AKLASLKAALHQTEALAEQAAARVTALVAKKAHLQYLRDFKLNPNRLQVIRERIDNTKQDLAKTSSLLNA
QEALAAALQAKQSSLEATIAATTEHQLTLLKTLANEKE

SEQ ID NO: 14 amino acid sequence comprising a leucine zipper motif within the second coiled-coil region of GAS 40.
QVIRERIDNTKQDLAKTSSLLNAQEALAAAL

SEQ ID NO: 15 amino acid sequence comprising SpA from *Streptococcus gordonii* Genbank reference GI 25990270
MNRKKEVFGFRKSKVAKTLCGAVLGAALIAIADQQVLADEVTETNSTANVAVTTTGNPATNLPEAQGEATE
AASQSQAQAGSKEGALPVEVSADDLNOAVTDAKAAGVNVVQDQTSKGTATTAENAQKQAEIKSDYAKQA
EETKKTTEAYKKEVEAHQAETDKINAENKAAEDKYQEDLKAHQAEVEKINTANATAKA EYEAKLAQYQKDL
AAVQKANEDSQLDYQNKLSAYQAEELARVQKANA EAKEAYEKAVKENTAKNAALQAENEA IKQRNETAKANY
DAAMKQY EADLAAIKKAKEDNDADYQAKLAAYQAEELARVQKANADAKAAYEKAVEENTAKNTAIQAENEA I
KQRNAAKATYEAALKQY EADLAAAKANEDSDADYQAKLAAYQTELARVQKANADAKAAYEKAVEDNKAK
NAALQAENEEIKQRNAAKTDYEA KLAKYEADLAKYKELAEYPAKLKAYEDEQAQIKAALVELEKNKNQD
GYLSKPSAQSLVYDSEPNQSLT'TNGKMLKASAVDEAF SHDTAQYSKKILQPDNLNVSYLQOQADVTS SM
ELYGNFGDKAGWTTT'VGNNTEVKFASVLLERQSVTATYTNLEKSYNGKKI SKAVFKYSLDSKFKNVD
KAWLGVLDPDPTLGVFASAYTGQEEKDTSIFIKNEFTFYDENDQPINFDNALLSVA SLNRENNSIEMAKDYS
GTFVKISGSSVGEKDGKIYATETLNFKQGQGSRW TMYKNSQPGSGWSSDAPNSWYGAGAI SMSGPTNHV
TVGAI SATQVVPSPVMAVATGKRPNIWYSLNGKIRAVNVPKITKEKPTPPVAPTEPQAPTYEVEKPLEPA
PVAPTYENEPTPPVKTPDQPEPSKPEEPTYETEKPLEPAPVVP TYENEPTPPVKTPDQPEPSKPEEPTYET
EKPLEPAPVAPTYENEPTPPVKTPDQPEPSKPEEPTYDPLPTPPVAPTPKQLPTPPVVPTVHFHYSSLLAQ
PQINKEIKNEDGVDIDRTLVAKQSIKFKELKTEALTAGRPKTTSFVLVDPLPTGYKFDL DATKAASTGFDT
TYDEASHTVTFKATDETLATYNADLTKPVETLHP TVVGRVNLNDGATYINNFTLTVNDAYGIKSNVVRVTP
GKPNPDNPNNNYIKPTKVNNKKEGLNIDGKEVLGSLAGSTNYELTWDL DQYKGDKSSKEAIQNGFYVDDY P
EEALDVRPDLVKVADEKGNQVSGVSVQYDSLEAAPKKVQDLLKKNITVKGAFQLFSADNPEEFYKQYVS
TGTSLVITDPM TVKSEFGKTGGKYENKAYQIDFGNGYATEVVVNNVPKITPKKDVTVSLDPTSENLDGQTV
QLYQTFNYRLIGGFIPQNHSELEDY SFVDDYDQAGDQYTGNYKTFSSSLNLTMKDGSVIKAGD LTSQTTA
ETDAANGIVTVRSKEDSLQKISLDSFPQAETYLQMRRIAIGTFENTYVNTVNVK VAYASNTVVRTTTP I P RTP
DKPTPIPTPKPKDPDKPETPKPEKVPSPKVEDPSAPI PVSVGKELTTLPKTGTNDSSYPYLG LAAALVGV L
GLGQLKRKEDESN

SEQ ID NO: 16 amino acid sequence comprising Streptococcal surface protein B precursor from *Streptococcus gordonii* Genbank reference GI 25055226 AAC44102.3

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MQKREVFGRKSKVAKTLCGAVLGAALIAIADQOVLADDEVTEFNSTANVAVTTTGNPATNLPEAQGEATEA
 ASQSQAQAGSKD GALPVEVSADDLNKAVTDAKAAGVNVVQDQTSKGTATTAAENAQKQAEIKSDYAKQAE
 EIKKTTEAYKKEVEAHQAETDKINAENKAAEDKYQEDLKAHQAEVEKINTANATAKAEYEAKLAQYQKDLA
 AVQKANEDSQLDYQNKLSAYQAE LARVQKANAEAKEAYEKAVKENTAKNAALQAENEAIKQRNETAKANYD
 AAMKQYEADLAAIKKAKEDNDADYQAKLAAYQAE LARVQKANADAKAAAYEKAVEENTAKNTAIQAENEAIK
 QRNETAKATYEA AVKQYEADLAAVQANATNEADYQAKLAAYQTE LARVQKANADAKATY EKAVEDNKAKN
 AALQAENEAIKQRNAAAKTDYEA KLAKYEADLAKYKKDFAAYTAALAEAESKKKQDGYLSEPRSQSLNFKS
 EPNAIRTIDSSVHQYQQELDALVKS WGISPTNPD RKKSTAYS YFNAINSNNTYAKLVLEKDKPVDVVTYTG
 LKNSSFNGKKISKVVYTYTLKETGFDDGTKMTMFASSDPTVTAWYNDYFTSTNINVKVKFYDEEGQLMNL
 GGLVNFSSLN RNGSGAIDKDAIESVRN FNGRYIPI SGSSIKIHENNSAYADSSNAEKSRGARWDTSEWDT
 TSSPNNWYGAI VGEITQSEISFNMASSKSGNIWF AFNSNINAIGVPTKPVAPTAPTQPMYETEKPLEPAPV
 VPTYENEPTPPVKTPDQPEPSKPEEPTYETEKPLEPAPVAPT YENEPTPPVKIPDQPEPSKPEEPTYETEK
 PLEPAPVAPT YENEPTPPVKTPDQPEPSKPEEPTYDPLPTPLAPTPKQLPTPPVVPTVHFHYSSLLAQPO
 INKEIKNEDGVDIDRTLVAKQSIGK FELKTEALTAGRPKTT SFVLVDPLPTGYKFDL DATKAASTGFDTTY
 DEASHTVTFKATDETLATYNADLTKPVETLHPTLVGRVLNDGATYTNNFTLTVNDAYGIKSNVVRVTTPGK
 PNDPDPNNNYIKPTKVNKNKEGLNIDGKEVLVAGSTNYIELTWDLDQYKGDKSSKEAIQNGFYVDDYPEE
 ALDVRPDLVKVADEKGNQVSGVSVQYDSLEAAPKKVQDLLK KANTVKGAFQLFSADNPEEFYKQYVSTG
 TSLVITDPM TVKSEFGKTGGKYENKAYQIDFGNGYATEVVVNNVPKITPKKDVTVSLDPTSENLDGQTVQL
 YQTFNYRLIGGFIPQNHSEEELEDYSFVDDYDQAGDQYTGNYKTFSSLNLTMKDGSVIKAGTDLTSQTTAET
 DATNGIVTVRFKEDFLQKISLDS PFQAETYLQMRRIAIGTFENTYVNTVNVK VAYASNTVVRTTPIPRTPDK
 PTPIPTPKPKDPDKPETPKPEKVPSPKVEDPSAPIPVSVGKELTTLPKTGTNDATYMPYLGLAALVGFLGL
 GLAKRKED

SEQ ID NO: 17 amino acid sequence comprising PspA from *Streptococcus pneumoniae*
 Genbank reference GI 282335

MNKKMILTSLSAVAILGAGFVASQPTVVRAEESPVASQSKAEKDYDAAKDKAKNAKKA VEDAQKALDDAK
 AAQKKYDEDQKKTEEKA ALEKAASEEMDKAVAAVQQAYLAYQQATDKAAKDAADKMIDEAKKREBEAKTKF
 NTVRAMVVPEPEQLAETKKKSEEAKQKAPELTKKLEEA KAKLEEA EK KATEAKQKVDAAEVAPQAKIAELE
 NQVHRLEQELKEIDESESEDYAKEGFRAPLQSKLDAKKAKLSKLEELSDKIDELDAEIAKLEDQLKAAEEN
 NNVEDYFKEGLEKTI AAKKAELEKTEADLKKAVNEPEK PAPA PETPAPEAPAEQPKPAPAPQAPAPKPEK
 PAEQPKPEKTDQQA EEDYARRSEEEYNRLTQQQPPKAEK PAPA PKTGWKQENG MWFYFYNTDGS MATGWLQ
 NNGSWYYLNSNGAMATGWLQYNGSWYYLNANGAMATGWAKVNGSWYYLNANGAMATGWLQYNGSWYYLNAN
 GAMATGWAKVNGSWYYLNANGAMATGWLQYNGSWYYLNANGAMATGWAKVNGSWYYLNANGAMATGWVKDG
 DTWYYLEASGAMKASQWFKVSDKWYYVNLGALAVNTTVDGYKVNANGEW

SEQ ID NO: 18 amino acid sequence comprising a portion of Se89.9 of *Streptococcus equi*
 Genbank reference GI 2330384

ESDIVDATRFSTTEIPKSGQVIDRSASIQALTNDIASIKGKIASLESRLADPSSEA EVTAAQAKISQLQH
 QLEAAQAKSHKLDQOQEQLANTKDSLRTQLLAAKEEQAQLKANLDKALALLASSKATLHKLEAAMEEAKA
 RVAGLASQKAQLEDLLAF EKPNRI ELAQEKVAAAKKALADTEDKLLAAQASLSDLQAQRARLQLSIATI

SEQ ID NO: 19 polynucleotide sequence comprising GST-40-HIS

CTGGTTCGGCGTGGATCCCATATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGG
 AGAAACGAAGCGCAGTAATACTCAGCAGATAGTTTACC AAAACCAGAAACAATTCAAGAGGCAAAGGCAA
 CTATTGATGCAGTTGAAAAACTCTCAGTCAACAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACA
 AAAACTACTGCTGAAATCAACACTTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACA
 AGAAATTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAG
 AGTTAACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTCA
 GAACAAAAGCTAGCATTT CAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAAAACGTCTGA
 ACAAATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTA
 ATGATAATACAAAAGCATTAAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAA
 GTTAAAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAGAGGCAGAACTTAG
 TCGTCTTAAATCCTCAGCTCCGCTACTCAAGATAGCATTTGTGGGTAATAATACCATGAAAAGCACC GCAAG
 GCTATCCTCTTGAAGA ACTTAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTAT
 TACAAAGAGCATGCAGATCAAATATTGCCAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGATAT
 TCCAGCAGATCGTAATCGCTTTGTTGATCCCGATAAATTGACACCAGAAGTGCAA AATGAGCTAGCCGAGT

SEQUENCE LISTING

TTGCAGCTCACATGATTAATAGTGTAAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCA
CAAGAATTTGCAAGATTACTTAGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATCATTTGTCTA
CGGACAGCCAGGGGTATCAGGGCATTATGGTGTGGGCCTCATGATAAAAACCTATTATTGAAGACTCGCCG
GAGCGTCAGGGCTCATTGCAAAATGATGATAACATGTACGAGAATATCGGTGCTTTTACGATGTGCATACT
GTGAATGGTATTTAAACGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAA
TACATACGGCCATGCTATTAACCTTTTACGTGTAGATAAAACATAACCCTAATGCGCCTGTTTACC'TTGGAT
TTTCAACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTTCAGAGTCTAACAT'TGCTAACCAT
CAACGCTTTAATAAGCCCTATAAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCAC'TGT
ATCTGATAC'TATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTTCATCAAG
AAGCTGATATTTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAG
TCAGACAGCTTAAATCTCCAAGTGAGACAATTAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGC
AGCTAAAGCAAACAAGCACAACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAG
CCGCACTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGCAGCCAGAGTGACAGCACTGGTGGCTAAAAAA
GCTCATTTGCAATATCTAAGGGACTTTAAATTTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGA
TAATACTAAGCAAGATTTGGCTAAAAC'TACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTAC
AAGCTAAACAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAAACCTTA
GCTAACGAAAAGGAATATGCCACTTAGACGAAGATATAGTACTGTGCTGATTTGCAAGTAGCTCCACC
TCTTACGGGCGTAAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAAATGGTTAAAG
AAACGAAAACAAC'TATTAGAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTT
GTTGGCCAAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCC
CTCATCTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTA
CTCAAAGAGCTCTTAAAGCAGGAGTGTGTCATGTTGGCAGCTGTGCGCCTCACAGGATTTAGGTTCCGTAAG
GAATCTAAGGCGGCCGCACTCGAGCACCACCACCACCACCAC

SEQ ID NO: 20 amino acid sequence comprising GST-40-HIS

L V P R G S H Met S V G V S H Q V K A D D R A S G E T K A S N T H D D S
L P K P E T I Q E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T
K T T A E I N H L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E
T L L A Q G A E H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E
Q K A S I S A E T T R A Q D L V E Q V K T S E Q N I A K L N A Met I S N
P D A I T K A A Q T A N D N T K A L S S E L E K A K A D L E N Q K A K V
K K Q L T E E L A A Q K A A L A E K E A E L S R L K S S A P S T Q D S I
V G N N T Met K A P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y
K E H A D Q I I A K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L
T P E V Q N E L A Q F A A H Met I N S V R R Q L G L P P V T V T A G S Q
E F A R L L S T S Y K K T H G N T R P S F V Y G Q P G V S G H Y G V G P
H D K T I I E D S A G A S G L I R N D D N Met Y E N I G A F N D V H T V
N G I K R G I Y D S I K Y Met L F T D H L H G N T Y G H A I N F L R V D
K H N P N A P V Y L G F S T S N V G S L N E H F V Met F P E S N I A N H
Q R F N K T P I K A V G S T K D Y A Q R V G T V S D T I A A I K G K V S
S L E N R L S A I H Q E A D I Met A A Q A K V S Q L Q G K L A S T L K Q
S D S L N L Q V R Q L N D T K G S L R T E L L A A K A K Q A Q L E A T R
D Q S L A K L A S L K A A L H Q T E A L A E Q A A A R V T A L V A K K A
H L Q Y L R D F K L N P N R L Q V I R E R I D N T K Q D L A K T T S S L
L N A Q E A L A A L D Q A K Q S D L E A T I A T T E H Q L T L L K T L A N
E K E Y R H L D E D I A T V P S D L E A P P L T G V K P L S Y S K I D T
T P L V Q E Met V K E T K Q L L E A S A R L A A E N T S L V E A L V G
Q T S E Met V A S N A I V S K I T S S I T Q P S S K T S Y G S G S S T T
S N L I S D V D E S T Q R A L K A G V V Met L A A V G L T G F R F R K E
S K A A A L E H H H H H H

SEQ ID NO: 21 polynucleotide sequence comprising 40a-HIS

ATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATAC
TCACGACGATAGTTTACCAAAAACAGAAAACAATTCAGAGGCAAGGCAACTATTGATGCAGTTGAAAAAA
CTCTCAGTCAACAAAAGCAGAAGTACAGAGCTTGCTACCGCTCTGACAAAACCTACTGCTGAAATCAAC
CACTTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCT

SEQUENCE LISTING

TGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAG-
AGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTGTCAGAACAAAAAGCTAGCATTTC
GCAGAACTACTCGAGCTCAAGATTTAGTGGAAACAAGTCAAACGCTCTGAACAAAAATATTGCTAAGCTCAA
TGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTAA
GCTCAGAAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAAAAAGCAATTGACTGAA
GAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGCTCTTAAATCCTCAGCTCC
GTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAACACCGCAAGGCTATCCTCTTTGAAGAACTTA
AAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATACAAAGAGCATGCAGATCAA
ATTATTGCCAAAGCTAGTGTCCAGGTAATCAATTAATCAATACCAAGATATCCAGCAGATCGTAATCGCTT
TGTTGATCCCATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATA
GTGTAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAGAATTGCAAGATTACTT
AGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTATCAGG
GCATTATGGTGTGGGCTCATGATAAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATTCGAA
ATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACTGTGAATGGTATTAAACGTGGT
ATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTATTAA
CTTTTACGTGTAGATAAACATAACCCCTAATGCGCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGAT
CTTTGAATGAACACTTTGTAATGTTCCAGAGCTAACATTGCTAACCATCAACGCTTAAATAAGACCCCT
ATAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGCAGCGAT
CAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTCCGGCTATTCATCAAGAAGCTGATATTATGGCAGCCC
AAGCTAAAGTAAGTCAACTTCAAGGTAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAA
GTGAGACAATTAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAAACAAGCACA
ACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACAGAAG
CCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACTGGTGGCTAAAAAGCTCATTGTGAATATCTAAGG
GACTTTAAATGGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATTTGGC
TAAACTACTCTATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGTCTAG
AAGCTACTATTGCTACCACAGAACCAGTTGACTTTGCTTAAACCTTAGCTAACGAAAAGGAATATCGC
CACCTTAGACGAAGATATAGCTACTGTGCTGATTGCAAGTAGCTCCACCCTTACGGGCGTAAACCCGCT
ATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAATGGTTAAAGAAACGAAACAACATATTAGAAG
CTTACAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGAAATG
GTAGCAAGTAATGCCATTGTGTCTAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTTATGG
CTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAAGGTCGGGCCGCACTCG
AGCACCACCACCACCACCACC

SEQ ID NO: 22 amino acid sequence comprising 40a-HIS

M S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q
E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H
L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E
H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E
T T R A Q D L V E Q V K T S E Q N I A K L N A Met I S N P D A I T K A A
Q T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L
A A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A
P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A
K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A
Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y
K K T H G N T R P S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A
G A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S I
K Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G F
S T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G S
T K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E A
D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T
K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L
H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N R
L Q V I R E R I D N T K Q D L A K T S S L L N A Q E A L A A L Q A K Q
S S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T V
P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L
L E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K I

SEQUENCE LISTING

T S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R A A A
L E H H H H H H H

SEQ ID NO: 23 polynucleotide sequence comprising 40a-RR-HIS

ATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATAC
TCACGACGATAGTTTACCAAACCAGAAAACAATTCAAGAGGCCAAAGGCAACTATTGATGCAGTTGAAAAA
CTCTCAGTCAACAAAAAGCAGAATGACAGAGCTTGCTACCGCTCTGACAAAAACTACTGCTGAAATCAAC
CACTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCT
TGCAAGTAGTGAGGAGACGCATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAG
AGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTCAGAACAAGGCTAGCATTTCAG
GCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGCTCTGAACAAAATATTGCTAAGCTCAA
TGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTAA
GCTCAGAAATGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGGCTAAAGTTAAAAGCAATTGACTGAA
GAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGCTTAAATCCTCAGCTCC
GTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAACACCGCAAGGCTATCCTCTTGAAGAACTTA
AAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAGAGCATGCAGATCAA
ATTATTGCCAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGATATCCAGCAGATCGTAATCGCTT
TGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATA
GTGTAcGtcGtCAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATTACTT
AGTACCAGCTATAAGAAAACTCATGGTAATACAAGACCATCATTTGTCACGGACAGCCAGGGGTATCAGG
GCATTTATGGTGTGGGCCCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATTGAA
ATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACTGTGAATGGTATTAAACGTGGT
ATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTATTAA
CTTTTACGTGTAGATAAACAATAACCCCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGAT
CTTTGAATGAACACTTTGTAATGTTTCCAGAGCTTAACATTGCTAACCATCAACGCTTTAATAAGACCCCT
ATAAAGCCGTTGGAAGTACAAAAGATTATGCCCCAAAGAGTAGGCACGTATCTGATACTATTGCAGCGAT
CAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTCATCAAGAAGCTGATATTATGGCAGCCC
AAGCTAAAGTAAGTCAACTTCAAGGTAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAA
GTGAGACAATTAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACAAGCACA
ACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACAGAAG
CCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACTGGTGGCTAAAAAGCTCATTGCAATATCTAAGG
GACTTTAAATGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATTTGGC
TAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGTCTAG
AAGCTACTATTGCTACCACAGAACCAGTTGACTTTGCTTAAACCTTAGCTAACGAAAAGGAATATCGC
CACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTACTCCACCTCTTACGGGCGTAAACCGCT
ATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAATGGTTAAAGAAACGAAAACAATATTAGAAG
CTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGAAATG
GTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTTATGG
CTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAAGtGCGGCCGCACTCG
AGCACCACCACCACCACCAC

SEQ ID NO: 24 amino acid sequence comprising 40a-RR-HIS

M S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q
E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H
L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E
H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E
T T R A Q D L V E Q V K T S E Q N I A K L N A Met I S N P D A I T K A A
Q T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L
A A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A
P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A
K A S P G N Q E L N V R R Q D I P A D R N R F V D P D N L T P E V Q N E L A
Q F A A H M I N S V R Y R Q L G L P P V T V T A G S Q E F A R L L S T S Y
K K T H G N T R P S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A
G A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S I
K Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G F
S T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G S

SEQUENCE LISTING

T K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E A
 D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T
 K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L
 H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N R
 L Q V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q
 S S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T V
 P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L
 L E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K I
 T S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R A A A
 L E H H H H H H H H

SEQ ID NO: 25 polynucleotide sequence comprising 40a-RR (nat)

ATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGACCTCAGGAGAAACGAAGGCGAGTAATAC
 TCACGACGATAGTTTACCAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAA
 CTCTCAGTCAACAAAAGCAGAAGTACAGAGCTTGCTACCGCTCTGACAAAACCTACTGCTGAAATCAAC
 CACTTAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCT
 TGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAG
 AGCTTCATAATGCTCAAGCAGATCAACATTTCAAAGAGACTGCATTTGTCAGAACAAAAGCTAGCATTTC
 GCAGAACTACTCGAGCTCAAGATTTAGTGAACAAGCTCAAACGCTGTAACAATAATGCTAAAGCTCAA
 TGCATATGATTAGCAATCTTGATGCTACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTAA
 GCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAAAAGCAATTGACTGAA
 GAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAAGCTTAGTCGCTTAAATCTCAGCTCC
 GTCCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCAGGCTATCCTCTTGAAGAAGTTA
 AAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGATCAA
 ATTTATTGCCAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGATATTCAGCAGATCGTAATCGCTT
 TGTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATA
 GTGTAGGtGtCAATTAGGCTTACCACCAGTACTGTTACAGCAGGATCACAAGAATTTGCAAGATTACTT
 AGTACCAGCTATAAGAAAACCTCATGGTAATAACAAGACCATCATTTGCTTACGGACAGCCAGGGGATCAGG
 GCATTTATGGTGTGGGCCCTCATGATAAAAACCTATTTATGAAAGACTCTGCCGGAGCTCAGGGCTCATTCGAA
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 ATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTATTAA
 CTTTTTACGTGTAGATAAACATAACCCTAATGCGCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGAT
 CTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGACCCCT
 ATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGCAGCGAT
 CAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTTCATCAAGAAGCTGATATTATGGCAGCCC
 AAGCTAAAGTAAGTCAACTTCAAGGTAATTTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAA
 GTGAGACAATTAATGATCACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAAACAAGCACA
 ACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACAGCAGAGAAG
 CCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACCTGGTGGCTAAAAAAGCTCATTGCAATATCTAAGG
 GACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATTGGC
 TAAAACCTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGTCTAG
 AAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAAACCTTAGCTAACGAAAAGGAATATCGC
 CACTTAGACGAAGATATAGCTACTGTGCCCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAAACCGCT
 ATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAATGGTTAAAGAAAACGAAAACAATATTAGAAG
 CTTACAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGAAATG
 GTAGCAAGTAATGCCAATTGTGCTAAAATCACATCTTCGATTACTAGCCCTCATCTAAGACATCTTATGG
 CTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAAGt

SEQ ID NO: 26 amino acid sequence comprising 40a-RR (nat)

M S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q
 E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H
 L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E
 H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E
 T T R A Q D L V E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q
 T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A
 A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A P

SEQUENCE LISTING

Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K
A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A Q
F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y K
K T H G N T R P S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A G
A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S I K
Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G F S
T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G S T
K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E A D
I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T K
G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L H
Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N R L
Q V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q S
S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T V P
D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L L
E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K I T
S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R

SEQ ID NO: 27 polynucleotide sequence comprising HIS-40a NH

ATGGGATCGCATCACCATCACCATCACGCTAGTAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAG
AGCCTCAGGAGAAACGAAGGCGAGTAATACTCAGCAGATAGTTTACCAAAACAGAAACAATTCAAGAGG
CAAAGGCAACTATTGATGCAGTTGAAAAACTCTCAGTCAACAAAAGCAGAAC TGACAGAGCTTGCTACC
GCTCTGACAAAACTACTGCTGAAATCAACCACCTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAAC
CTCTGCACAAGAAATTTACACTAATACTCTTGCAAGTAGTGAGGAGACCGTATTAGCCCAAGGAGCCGAAC
A C C A A G A G A G T T A A C A G C T A C T G A A A C A G A G C T T C A T A A T G C T C A A G C A G A T C A A C A T T C A A A G A G A C T
GCATTTGTCAGAACAAAAGCTAGCATTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAA
AACGCTTGAACAAAATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAGCAGCTC
AAACGGCTAATGATAATACAAAAGCATTAAAGCTCAGAATTTGGAGAAGGCTAAAAGCTGACTTAAAGAAATCAA
AAAGCTAAAGTTAAAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAGAGGC
AGAACTTAGTCGCTTAAATCCTCAGCTCCGCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAG
CACCGCAAGGCTATCCTCTTGAAGAACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTAC
AATAATTATTACAAGAGCATGCAGATCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAATCAATA
CCAAGATATTCAGCAGATCGTAATCGCTTTGTTGATCCCATAATTTGACACCAGAAGTGCAAAATGAGC
TAGCGCAGTTTGACGCTCACATGATTAATAGTGTAAAGAACAATTAGGTCACCACCAGTTACTGTTACA
GCAGGATCACAAGAATTTGCAAGATTACTTAGTACCAGCTATAAGAAAACTCATGGTAATACAAGACCATC
ATTTGCTACGGACAGCCAGGGTATCAGGGCATTAGGTTGTTGGCCCTCATGATAAAACTATTATTGAAG
ACTCTGCCGGAGCGTCAGGGCTCATTGAAATGATATAACATGTACGAGAATATCGGTGCTTTTAAAGAT
GTGCATACGTGAATGGTATTAACGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTT
ACACGGAAATACATACGGCCATGCTATTAACCTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTT
ACCTTGGATTTTCAACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATT
GCTAACCATCAACGCTTTAATAAGACCCCTATAAAAAGCCGTTGGAAGTACAAAAGATATGCCCAAAGAGT
AGGCACGTATCTGATACTATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTTGTCGGCTA
TTCATCAAGAAGCTGATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACA
CTTAAGCAGTCAGACAGCTTAAATCTCCAAGTGAGACAATTAATGATACTAAAGGTTCTTTGAGAACAGA
ATTACTAGCAGCTAAAGCAAAAACAAGCACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCAT
CGTTGAAAGCCGCACTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGACAGCCAGAGTGACAGCACTGGTG
GCTAAAAAGCTCATTTGCAATATCTAAGGGACTTTAAATTTGAATCCTAACCGCCTTCAAGTGATACGTGA
GCGCATTGATAATACTAAGCAAGATTTGGCTAAAACCTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAG
CAGCCTTACAAGCTAAACAAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTT
AAAACCTTAGCTAACGAAAAGGAATATCGCCACTTAGACGAAGATATAGCTACTGTGCTGATTTGCAAGT
AGCTCCACCTCTTACGGGCGTAAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAA
TGGTTAAAGAAACGAAACACTATTAGAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCA
GAAGCGCTTGTGGCCAAACCTCTGAAATGGTAGCAAGTAAATGCCATTGTGTCTAAAATCACATCTTCGAT
TACTCAGCCCTCATCTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTG
ATGAAAGTACTCAACGt

SEQ ID NO: 28 amino acid sequence comprising HIS-40a NH

SEQUENCE LISTING

M G S H H H H H A S S V G V S H Q V K A D D R A S G E T K A S N T H D
 D S L P K P E T I Q E A K A T I D A V E K T L S Q Q K A E L T E L A T A
 L T K T T A E I N H L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S
 E E T L L A Q G A E H Q R E L T A T E T E L H N A Q A D Q H S K E T A L
 S E Q K A S I S A E T T R A Q D L V E Q V K T S E Q N I A K L N A M I S
 N P D A I T K A A Q T A N D N T K A L S S E L E K A K A D L E N Q K A K
 V K K Q L T E E L A A Q K A A L A E K E A E L S R L K S S A P S T Q D S
 I V G N N T M K A P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y
 K E H A D Q I I A K A S P G N Q L N V Y Q D I P A D R N R F V D P D N L
 T P E V Q N E L A Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E
 F A R L L S T S Y K K T H G N T R P S F V Y G Q P G V S G H Y G V G P H
 D K T I I E D S A G A S G L I R N D D N M Y E N I G A F N D V H T V N G
 I K R G I Y D S I K Y M L F T D H L H G N T Y G H A I N F L R V D K H N
 P N A P V Y L G F S T S N V G S L N E H F V M F P E S N I A N H Q R F N
 K T P I K A V G S T K D Y A Q R V G T V S D T I A A I K G K V S S L E N
 R L S A I H Q E A D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N
 L Q V R Q L N D T K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A
 K L A S L K A A L H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L
 R D F K L N P N R L Q V I R E R I D N T K Q D L A K T T S S L N A Q E
 A L A A L Q A K Q S S L E A T I A T T E H Q L T L L K T L A N E K E Y R
 H L D E D I A T V P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q
 E M V K E T K Q L L E A S A R L A A E N T S L V A E A L V G Q T S E M V
 A S N A I V S K I T S S I T Q P S S K T S Y G S G S S T T S N L I S D V
 D E S T Q R

SEQ ID NO: 29 polynucleotide sequence comprising HIS-40a CH

ATGGCTAGTAGTGTAGGCGTATCTACCAAGTCAAAGCAGATGATAGAGCCCTCAGGAGAAACGAAGGCCGAG
 TAATACTCAGCAGCAGATAGTTTACCAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTG
 AAAAACTCTCAGTCAACAAAAGCAGAAGTACAGAGCTTGCTACCGCTCTGACGAAAACACTGCTGAA
 ATCAACCAATTTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAA
 TACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTG
 AAACAGAGCTTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTCAGAACAAAAGCTAGC
 ATTTACAGCAGAACTACTCGAGCTCAAGATTTAGTGGAAACAAGTCAAACGCTCGAACAAAATATTGCTAA
 GCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAAGCAGCTCAAACGGCTAATGATAATACAAAAG
 CATTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAAAAGCAATTG
 ACTGAAGAGTTGGCAGCTCAGAAAAGCTGCTCTAGCAGAAAAGAGGGCAGAACTTAGTCGCTTAAATCCTC
 AGCTCCGCTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTATCCTCTTGAAG
 AACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCA
 GATCAAATTTATGCCAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGATATTCCAGCAGATCGTAA
 TCGCTTTGTTGATCCCATAATTTGACACCAGAAGTGCAAAAATGAGCTAGCGCAGTTTGCAGCTCACATGA
 TTAATAGTGTAAGAAGACAATTAGGCTTACCACCAGTTACTGTTACAGCAGGATCACAGAATTTGCAAGA
 TTACTTAGTACCAGCTATAAGAAACTCATGGTAATACAAGACCATCATCTGCTTACGGACAGCCAGGGGT
 ATCAGGGCATTATGGTGTGGGCCCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCA
 TTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACGTGTAATGGTATTTAAA
 CGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGC
 TATTAACTTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATG
 TAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGCTAACATTTGCTAACCATCAACGCTTTAATAAG
 ACCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACATTGTC
 AGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTCATCAAGAAGCTGATATTATGG
 CAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAAT
 CTCCAAGTGAGACAATTAATGATCTAAAGGTTCTTTGAGAACAGAAATTACTAGCAGCTAAAGCAAACA
 AGCACAACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACCTGCACCAGA
 CAGAAGCCTTAGCAGAGCAAGCCGACAGTAGTACAGCAGCTGGTGGCTAAAAAGCTCATTTGCAATAT
 CTAAGGGACTTTAAATTTAATCCTAACCCGCTTCAAGTATGATACGTGAGCGCATTGATAATACTAAGCAAGA
 TTTGGCTAAAACCTCATCTTTGTTAAATGCACAAGAGCTTTAGCAGCCTTACAAGCTAAACAAAGCA
 GTCTAGAAGCTACTATTGCTACCACAGAACCAGTTGACTTTGCTTAAAACCTTAGCTAACGAAAAGGAA

SEQUENCE LISTING

TATCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAA
 ACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAGAAACGAAACAACATAT
 TAGAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCT
 GAAATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATC
 TTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTCTGATGTTGATGAAAGTACTCAACGtCGCGCCG
 CACTCGAGCACCACCACCACCACCAC

SEQ ID NO: 30 amino acid sequence comprising HIS-40a CH

M A S S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T
 I Q E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I
 N H L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G
 A E H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S
 A E T T R A Q D L V E Q V K T S E Q N I A K L N A M I S N P D A I T K A
 A Q T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E
 L A A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K
 A P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I
 A K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L
 A Q F A A H M I N S V R R Q L G L P V T V T A G S Q E F A R L L S T S
 Y K K T H G N T R P S ~~E~~ V Y G Q P G V S G H Y G V G P H D K T I I E D S
 A G A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S
 I K Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G
 F S T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G
 S T K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E
 A D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D
 T K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A
 L H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N
 R L Q V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K
 Q S S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T
 V P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q
 L L E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K
 I T S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R A A
 A L E H H H H H H

SEQ ID NO: 31 polynucleotide sequence comprising HIS-40a-RR NH

ATGGGATCGCATCACCATCACCATCAGCCTAGTAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAG
 AGCCTCAGGAGAAACGAAGGCGAGTAATACTCACGACGATAGTTTACCAAACAGAAACAATTCAAGAGG
 CAAAGGCAACTATTGATGCAGTTGAAAAACTCTCAGTCAACAAAAGCAGAAGTACAGAGCTTGCTACC
 GCTCTGACAAAACTACTGCTGAAATCAACCCTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAAC
 CTCTGCACAAGAAATTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAAC
 ATCAAAGAGAGTTAACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACT
 GCATTGTCAGAACAAAAGCTAGCATTTTCAGCAGAAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAA
 AACGCTGTAACAAAATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTC
 AAACGGCTAATGATAATACAAAAGCATTAAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAA
 AAAGCTAAAGTTAAAAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGC
 AGAAGCTTAGTCGCTTAAATCCTCAGCTCCGCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAG
 CACCGCAAGGCTATCCTCTTGAAGAACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTAC
 AATAATTATTACAAAGAGCATGCAGATCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATA
 CCAAGATATTCCAGCAGATCGTAATCGCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGC
 TAGCGCAGTTTGCAGCTCACATGATTAATAGTGTACGtGtCAATTAGGTCTACCACCAGTFACTGTTACA
 GCAGGATCACAAGAATTTGCAAGATTACTTAGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATC
 ATTTGTCTACGGACAGCCAGGGGTATCAGGGCATTATGGTGTGGGCTCATGATAAAACTATTATTGAAG
 ACTCTGCCGAGCGCTCAGGGCTCATTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTACAGATCAT
 GTGCATACTGTGAATGGTATTAAACGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTT
 ACACGGAAATACATACGGCCATGCTATTAACTTTTTACGTGTAGATAAACATAACCCTAATCGCCCTGTTT
 ACCTTGGATTTTCAACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATT
 GCTAACCATCAACGCTTTAATAAGACCCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGT

SEQUENCE LISTING

AGGCACTGTATCTGATACTATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTCCGGCTA
TTCATCAAGAAGCTGATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACA
CTTAAGCAGTCAGACAGCTTAAATCTCCAAGTGAGACAATTAATGATACTAAAGGTTCTTTGAGAACAGA
ATTACTAGCAGCTAAAGCAAACAAGCACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCAT
CGTTGAAAAGCCGCACTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGCAGCCAGAGTGACAGCACTGGTG
GCTAAAAAAGCTCATTGCAATATCTAAGGGACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGA
CGCATTGATAATACTAAGCAAGATTTGGCTAAAACCTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAG
CAGCCTTACAAGCTAAACAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCCTT
AAAACCTTAGCTAACGAAAAGGAATATCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGT
AGCTCCACCTCTTACGGGCGTAAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAA
TGTTTAAAGAAAACGAAAACAACCTATTAGAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCA
GAAGCGCTTGTGTCGCAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGAT
TACTCAGCCCTCATCTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTCTGATGTTG
ATGAAAGTACTCAACGt

SEQ ID NO: 32 amino acid sequence comprising HIS-40a-RR NH

M G S H H H H H H A S S V G V S H Q V K A D D R A S G E T K A S N T H D
D S L P K P E T I Q E A K A T I D A V E K T L S Q Q K A E L T E L A T A
L T K T T A E I N H L K E Q Q D N E Q K A L T S A Q E I Y H N T L A S S
E E T L L A Q G A E H Q R E L T A T E T E L H N A Q A D Q H S K E T A L
S E Q K A S I S A E T T R A Q D L V E Q V K T S E Q N I A K L N A M I S
N P D A I T K A A Q T A N D N T K A L S S E L E K A K A D L E N Q K A K
V K K Q L T E E L A A Q K A A L A E K E A E L S R L K S S A P S T Q D S
I V G N N T M K A P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y
K E H A D Q I I A K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L
T P E V Q N E L A Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E
F A R L L S T S Y K K T H G N T R P S F V Y G Q P G V S G H Y G V G P H
D K T I I E D S A G A S G L I R N D D N M Y E N I G A F N D V H T V N G
I K R G I Y D S I K Y M L F T D H L H G N T Y G H A I N F L R V D K H N
P N A P V Y L G F S T S N V G S L N E H F V M F P E S N I A N H Q R F N
K T P I K A V G S T K D Y A Q R V G T V S D T I A A I K G K V S S L E N
R L S A I H Q E A D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N
L Q V R Q L N D T K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A
K L A S L K A A L H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L
R D F K L N P N R L Q V I R E R I D N T K Q D L A K T T S S L L N A Q E
A L A A L Q A K Q S S L E A T I A T T E H Q L T L L K T L A N E K E Y R
H L D E D I A T V P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q
E M V K E T K Q L L E A S A R L A A E N T S L V A E A L V G Q T S E M V
A S N A I V S K I T S S I T Q P S S K T S Y G S G S S T T S N L I S D V
D E S T Q R

SEQ ID NO: 33 polynucleotide sequence comprising 40N-HIS

ATGCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATACTCACGACGATAGTTTACC
AAAACAGAAAACAATTCAAGAGGCAAAGGCAACTATTTGATGCAGTTGAAAAAATCTCTCAGTCAACAAAAG
CAGAACTGACAGAGCTTGCTACCGCTCTGACAAAAACTTGTGTAATCAACCACTTAAAAGAGCAGCAA
GATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAATTTACTACTAATACTCTTGCAAGTAGTGAGGAGAC
GCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAGAGCTTCATAATGCTCAAG
CAGATCAACATTCAAAAGAGACTGCATTGTCAGAACAAAAGCTAGCATTTTCAGCAGAACTACTCGAGCT
CAAGATTTAGTGGAACAAGTCAAACGCTGAAACAAAATATTGCTAAGCTCAATGCTATGATTAGCAATCC
TGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTAAGCTCAGAATTGGAGAAGG
CTAAAGCTGACTTAGAAAATCAAAGCTAAAAGTTAAAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAA
GCTGCTCTAGCAGAAAAAGAGGCGAAGCTTAGTCGCTCTAAATCCTCAGCTCCGCTACTCAAGATAGCAT
TGTGGGTAATAATACCATGAAAGCACCGCAAGGCTATCCTCTTGAAGAACTTAAAAAATTAGAAGCTAGTG
GTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGATCAAATTATTGCCAAAAGCTAGT
CCAGGTAATCAATTAATCAATACCAAGCGGCCGCACTCGAGCACCACCACCACCACCAC

SEQUENCE LISTING

SEQ ID NO: 34 amino acid sequence comprising 40N-HIS

M Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q E A K A T I
 D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H L K E Q Q D
 N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E H Q R E L T
 A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E T T R A Q D
 L V E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q T A N D N T
 K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A A Q K A A L
 A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A P Q G Y P L E
 E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K A S P G N Q
 L N Q Y Q A A A L E H H H H H H H

SEQ ID NO: 35 amino acid sequence comprising GAS 117

MTLKKHYLLSLLALVTVGAAFNTSQSVSAQVYSNEGYHQHLTDEKSHLQYSKDNAQLQLRNILDGYQNDLGRHYSSYYYYNLRTVMGLSSEQDIEKHYEELKNKLHDMYNHY

SEQ ID NO: 36 polynucleotide sequence encoding GAS 117

ATGACACTAAAAAACACTATTATCTTCTCAGCCTGCTAGCTCTTGTAACGGTTGGTGTGCCTTTAACAC
 AAGCCAGAGTGTTCAGTGCACAAGTTTATAGCAATGAAGGGTATCACCAGCATTGACTGATGAAAAATCAC
 ACCTGCAATATAGTAAAGACAACGCACAACCTCAATTGAGAAATATCCTTGACGGCTACCAAAATGACCTA
 GGGAGACACTACTCTAGCTATTATTACTACAACCTAAGAACCCTTATGGGACTATCAAGTGAGCAAGACAT
 TGAAAAACACTATGAAGAGCTTAAGAACAAGTTACATGATATGTACAATCATTATTAA

SEQ ID NO: 37 amino acid sequence comprising GAS 117 leader sequence

TLKKHYLLSLLALVTVGA

SEQ ID NO: 38 amino acid sequence comprising fragment of GAS 117 where leader sequence is removed

AFNTSQSVSAQVYSNEGYHQHLTDEKSHLQYSKDNAQLQLRNILDGYQNDLGRHYSSYYYYNLRTVMGLSSEQDIEKHYEELKNKLHDMYNHY

SEQ ID NO: 39 amino acid sequence comprising GAS 130

MSHMKRPEVLSPAGTLEKLVKVAIDYGADAVFVGGQAYGLRSRAGNFSMEELQEGIDYAHARGAKVYVAAN
 MVTHEGNEIGAGEWFRQLRDMGLDAVIVSDPALIVICSTEAPGLEIHLSTQASSTNYETFEFWKAMGLTRV
 VLAREVNMAELAEIRKRTDVEIEAFVHGAMCISYSGRCVLSNHMSHRDANRGGCSQSCRWKYDLYDMPFGG
 ERRSLKGEIPEDYSMSSVDMCMIDHIPDLIENGVDLSLIEGRMKS IHVYSTVTNCKYKAAVGYMESPEAFY
 AIKEELIDELWKVAQRELATGFYYGIPTENEQLFGARRKIPQYKFVGEVVAFDASMTATIRQRNVIIMEGD
 RIECYGPGFRHFETVVKDLHDADGQKIDRAPNPMELLTISLPREVKPGDMI RACKEGLVNLQKDGTSKTV
 RT

SEQ ID NO: 40 polynucleotide sequence encoding GAS 130

ATGTCACATATGAAAAACGTCCTCCGAGGCTTATCACCTGCTGGAACACTTGAAAAATTAAAAGTTGCGAT
 TGACTATGGCGCAGATGCTGTTTTTGTGGAGGGCAGGCCATATGGCCTAAGAAGCCGCGCTGGTAACTTCT
 CTATGGAAGAATTGCAAGAAGGCATTGATTATGCACATGCGCGTGGAGCTAAGGCTATGTTGCTGCTAAC
 ATGGTTACCCACGAAGGGAACGAAATTGGTGC GGCGAGTGGTTTCGTCAACTGCGTGATATGGGGCTTGA
 TCGCGTCAATTGTTTCAGATCCAGCCTTGATTGTTATTTGTTCACAGAAAGCCCCAGGTTTGGAAATTCATT
 TGTCAACGCAAGCTTCATCTACCAATTACGAGACCTTTGAATTTTGGAAAGCCATGGGCTTGACCCGAGTT
 GTTTTAGCTCGCGAGGTTAATATGGCCGAGTTAGCAGAAATCCGCAAGCGGACAGATGTGGAAATTGAAGC
 CTTTGTCCATGGAGCCATGTGTATCTCTTATTCAGGCCGCTGTGTTTTGTCAAACCATGAGTCACCGTG
 ATGCCAACAGGGGCGGCTGCTCACAGTCTTGCCGCTGGAAGTATGATTTGTATGACATGCCATTTGGAGGA
 GAGCGCCGCTCCTTAAAAGGGGAAATTCAGAAGACTATTCTATGTCCCTGTGACATGCTGATGATTGA
 CCATATCTCTGACCTGATTGAAAATGGGGTTGATAGCTTAAAAATGAAAGGCCAATGAAATCTATCCACT
 ACGTCTCAACCGTAACCACTGTTACAAGGCGGCTGTAGGTGCTTACATGGAAGCCAGAAAGCTTTTTAT
 GCTATCAAAGAGGAATTGATTGACGAGTTGTGGAAGGTTGCCAGCGGAGTTGGCTACAGGTTTTTACTA
 TGGTATCCCAACTGAAAATGAACAATTTTGGTGTCTGCCGAAAATTCACAATATAAATTTGTCCGAG
 AAGTAGTTGCCTTTACTCAGCTAGCATGACAGCGACCATTTCGTCAGCGTAATGTCATCATGGAAGGCGAT

SEQUENCE LISTING

CGGATTGAATGTTATGGACCAGGTTTCCGTCATTTTGAAACGGTTGTTAAGGACTTACATGATGCGGATGG
 CAAAAGATTGACCGTGCCCCAAATCCAATGGAACCTTAAACCATCTCTTTACCGAGAGAAGTTAAGCCAG
 GGGATATGATTAGGGCTTGCAAGGAAGGTCTGGTTAACCTCTATCAAAAAGATGGCACCAGTAAAACGTGTT
 AGAACATAG

SEQ ID NO: 41 amino acid sequence comprising GAS 277

MTTMQKTI SLLSLALLIGLLGTSGKAI SVYA QDQHTDNVIAESTISQVSVEASMRGTEPYIDATVTTDQPV
 RQPTQATI TLKDASDNTINSWVYTMAAQRRFTAWFDLTGQKSGDYHVTVTVHTQEKAVTGQSGTVHFDQN
 KARKPTNMQQKDT SKAMTNSVDVDTKAQTNQSANQEIDSTSNPFRSATNHRSTSLKRSTKNEKLTPTASN
 SQKNGSNKTKMLVDKEEVKPTSKRGFPWVLLGLVVS LAAGLFIAIQVSRRK

SEQ ID NO: 42 polynucleotide sequence encoding GAS 277

ATGACAAC TATGCAAAAACAATTAGCTTATTATCACTAGCTTTACTTATTGGTTTGC TGGGGACTTCTGG
 CAAAGCCATATCTGTGTATGCACAAGATCAGCACACTGATAATGTTATAGCTGAATCAACTATTAGTCAGG
 TCAGTGTGTAAGCCAGTATGCGTGGAACAGAACCTTATATGATGCTACAGTCACCACAGATCAACCTGTC
 AGACAACCACTCAGGCAACGATAACACTTAAAGACGCTAGTGATAATACTATTAATAGTTGGGTATATAC
 TATGGCAGCGCAACAGCGTCGTTTTACAGCTTGGTTTGATTTAACTGGACAAAAGAGTGGTGACTATCATG
 TAACTGTCCCGTTTCATACTCAAGAAAAGGCAGTAACTGGTCAATCAGGAAGTTCATTTTGATCAAAAAC
 AAAAGCTAGAAAACACCAACTAATATGCAACAAAAGGATACTTCTAAAGCAATGACGAATTCAGTCGATGT
 AGACACAAAAGCTCAAACAATCAATCAGCTAACCAAGAAATAGATTCTACTTCAAATCCTTTTCAGATCAG
 CTACTAATCATCGATCAACTTCCTTAAAGCGATCTACTAAAAATGAGAACTTACACCAACTGCTAGTAAT
 AGCCAAAAAACGGTAGCAACAAGACAAAATGCTAGTGGACAAAGAGGAAGTAAAACCTACTTCAAAAAG
 AGGATTCCTTGGGTCTTATTAGGTCTAGTAGTCAGTTTAGCTGCAGGTTTATTTATAGCTATTCAAAAAG
 TATCTAGACGAAAATAA

SEQ ID NO: 43 amino acid sequence comprising N-terminal leader sequence of GAS 277

TTMQKTI SLLSLALLIGLLGTSGKAI SVYA

SEQ ID NO: 44 amino acid sequence comprising fragment of GAS 277 where N-terminal leader sequence is removed

QDQHTDNVIAESTISQVSVEASMRGTEPYIDATVTTDQPV RQPTQATI TLKDASDNTINSWVYTMAAQRR
 FTAWFDLTGQKSGDYHVTVTVHTQEKAVTGQSGTVHFDQNKARKPTNMQQKDT SKAMTNSVDVDTKAQTN
 QSANQEIDSTSNPFRSATNHRSTSLKRSTKNEKLTPTASNSQKNGSNKTKMLVDKEEVKPTSKRGFPWVLL
 GLVVS LAAGLFIAIQVSRRK

SEQ ID NO: 45 amino acid sequence comprising GAS 236

MTQMNYTGKVKRVAIIANGKYQSKRVASKLFSVFKDDPDFYLSKKNPDIVISIGGDGMLLSAFHMYEKELD
 KVRFGIHTGHLGFYTDYRDFEVDKLDNLRKDKGEQISYPILKVAITLDDGRVVKARALNEATVKRIEKT
 MVADV IINHVKFESFRGDGISVSTPTGSTAYNKS LGGAVLHPTIEALQLTEISSLN RVFR TLGSSIIIPK
 KDKIELVPRKLGIIY TISIDNKTYQLKNVTKVEYFIDDEKIHVSSPSHTSFWERVKDAFIGEIDS

SEQ ID NO: 46 polynucleotide sequence encoding GAS 236

ATGACACAGATGAATTATACAGGTAAGGTA AAAACGAGTTGCTATTATTGCAAATGGTAAGTACCAAAGTAA
 ACGCGTCGCC TCCAAACTTTTCTCCGATTTAAAGATGATCCTGATTTCTATCTTTCAAAGAAAATCCGG
 ATATTGTGATTTCTATTGGCGGAGATGGGATGCTCTTATCTGCCTTTCACATGTATGAAAAGAATTAGAT
 AAGGTACGTTTTGTAGGAATCCACACCCGGTCATCTTGGCTTTTATACCGATTATAGGGATTTTGAAGTTGA
 TAAATTAATTGATAATTTAAGAAAAGACAAGGGAGAACAATCTCTTATCCGATTTTAAAAGTTGCTATTA
 CTTTAGATGATGGTCGTGTGGTTAAAGCGCGTGCTTTGAATGAAGCGACGGTTAAGCGTATTGAAAAAACC
 ATGGTAGCAGATGTTATTATTAACCATGTCAAATTTGAAAAGCTTCCGAGGTGATGGGATTTTCAGTATCGAC
 CCCGACAGGGAGCACAGCCTACAATAAATCTTTAGGTGGTGCTGTCTTGCATCCGACGATTGAAGCGCTGC
 AATTGACGGAAATTTCCAGTCTTAATAACCGTGTCTTTAGAACCCTTGGGCTCATCAATCATTATTTCCAAA
 AAAGATAAGATTGAGTTAGTGCCAAAACGATTAGGAATTTATACCATTCCATTGATAATAAAACCTATCA
 GTTAAAAAATGTGACGAAGGTGGAGTATTTATCGACGATGAGAAAATTCATTTTGTTCCTCTCCGAGTC
 ATACGAGCTTTTGGGAAAGGGTCAAGGATGCCTTATTGGAGAGATTGACTCATGA

SEQUENCE LISTING

SEQ ID NO: 47 amino acid sequence comprising N-terminus leader sequence of GAS 236
MTQM

SEQ ID NO: 48 amino acid sequence comprising a fragment of GAS 236 where the N-terminal leader sequence is removed

NYTGKVKRVAIIANGKYQSKRVASKLFSVFKDDPDFYLSKKNPDIVISIGGDGMLLSAFHMYEKELDKVRF
VGIHTGHLGFYTDYRDFEVDKLDLIDNLRKDKGEQISYPILKVAITLDDGRVVKARALNEATVKRIEKTMDVAD
VIINHVKFESFRGDGIVSSTPTGSTAYNKSLGGAVLHPTIEALQLTEISSLNRRVFRITLGSIIIPKKDKI
ELVPPKRLGIYTI SIDNKTYQLKNVTKVEYFIDDEKIHVSSPSHTSFWERVKDAFIGEIDS

SEQ ID NO: 49 amino acid sequence comprising GAS 389

MRNEMAKIMNVTGEEVIALAATYMTKADVAFVAKALAYATAAHFYQVRKSGEPYIVHPIQVAGILADLHLD
AVTVACGFLHDVVEDTDITLDEIEADFGHDARDIVDGVTKLGEVEYKSHEEQLAENHRKMLMAMSKDIRVI
LVKLABDLRHLNMRPLKHLRDKQERISRETMEIYAPLAHRLGISRKWELEDLAFRYLNETEFYKISHMMKE
KRREREALVEAIVSKVKTYTTQQGLFGDVYGRPKHIYSIYRKMMDKKRFDQIFDLIAIRCVMETQSDVYA
MVGYIHELWRPMPGRFKDYIAAPKANGYQSIHTTVYGPKGPIEIQIRTKDMHQVAEYGVAAHWAYKKGVRG
KVNQAEQAVGMNWIKELVELQDASNGDAVDFVDSVKEDIFSERIYVFTPTGAVQELPKESGPIDFAYAIHT
QIGEKATGAKVNGRMVPLTAKLKTGDVVEIITNANSFGPSRDWVKLVKTNKARNKIROFFKNQDKELSVNK
GRDLLVSYFQEQGYVANKYLDKRIEAILPKVSVKSEESLYAAVFGDISPISVFNKLTEKERREERAKA
KAEAEELVKGGEVKHENKDVLVKVRSENGVI IQGASGLLMRIAKCCNPVPGDPIDGYITKGRGIAIHRSDCH
NIKSQDGYQERLIEVEWDLNNSKDYQAEIDIYGLNRSGLLNDVLQILSNSTKSI STVNAQPTKDMKFANI
HVSFGIPNLTHLTTVVEKIKAVPDVYSVKRTNG

SEQ ID NO: 50 polynucleotide sequence encoding GAS 389

ATGAGGAACGAAATGGCAAAAATAATGAACGTAACAGGAGAAGAAGTCATTGCCTTAGCGGCCACCTATAT
GACCAAGGCTGATGTGGCTTTTGTGGCAAAGGCTTTAGCATATGCAACAGCGGCCATTTCTACCAAGTGA
GAAAGTCAGGCGAACCCATATATCGTCCATCCGATTCAGGTGGCGGGGATTC TGGCTGATTTGCATCTGGAT
GCTGTGACAGTTGCTTGTGGCTTTTTACATGATGTCGTAGAGATACGGATATTACCTTAGATGAGATCGA
AGCAGACTTTGGCCATGATGCTCGTGATATCGTTGATGGTGTCCACCAAGTTAGGTGAAGTTGAGTACAAAT
CTCATGAGGAGCAACTCGCCGAAAACCATCGCAAAATGCTGATGGCTATGTCCAAAGATATTCGCGTGATT
TTGGTGAAAATTGGCTGACCGCTGCATAATATGCGCACCCCTCAAACATTTGCGCAAGGACAAACAAGAGCG
CATTTTCGCGCGAAACCATGGAAATCTATGCCCCCTTGGCGCATCGTTTGGGGATTAGTCGCATCAAATGGG
AACTAGAAGATTTGGCTTTTTCGTTACCTCAATGAAACCGAATTTTACAAAATTTCCCATATGATGAAAGAA
AAACGTCGCGAGCGTGAAGCTTTGGTAGAGGCTATTGTCTAGTAAGGTCAAAACCTATACGACACAACAAGG
GTTGTTTGGAGATGTGTATGGCCGACCAAAACACATTTATTCGATTTATCGGAAAATGCGGGACAAAAAGA
AACGATTCGATCAGATTTTGTGATCTGATTGCCATTCGTTGTGTATGGAACGCAAAGCGATGTCTATGCT
ATGGTTGGCTATATTCATGAGCTTTGGCGTCCATGCCAGGCCGTTCAAGGATTATATTCAGCTCCTAA
AGCTAATGGCTACCAGTCTATTCATACCACCGTGTATGGGCCAAAAGGACCTATTGAGATTCAAATCAGAA
CTAAGGACATGCATCAAGTGGCTGAGTACGGGGTTGCTGCTCACTGGGCTTATAAAAAAGGCGTGCCTGGT
AAGTCAATCAAGCTGAGCAAGCCGTTGGCATGAACTGGATCAAAGAGCTGGTAGAATTGCAAGATGCCTC
AAATGGCGATGCAGTGGACTTTGTGGATTCCGTCAAAGAAGACATTTTTTCTGAACGGATTTATGTCTTTA
CACCGACAGGGGCCGTTTCCAGGATTTACCAAAAAGAAATCAGGTCCATTTGATTTTGTCTTATGCGATCCATACG
CAAATCGGTGAAAAGCAACAGGTGCCAAAGTCAATGGACGTATGGTTCCCTCTCAC TGCCAAGTTAAAAAC
AGGAGATGTGGTTGAAATCATCAAAATTCGTCAAGTTCTTTAAAAAATCAAGACAAGGAATTGTCAGTGAATAAA
GGCCGTGATTTGTGGTGTCTTATTTTCAAGAGCAGGGCTACGTTGCCAATAAATACCTTGACAAAAACG
CATTGAAGCCATCCTTCCAAAAGTCAGTGTGAAGAGCGAAGAATCACTCTATGCAGCCGTTGGGTTTGGTG
ACATTAGTCTTATCAGTGTCTTTAACAAGTTAACCGAAAAAGAGCGCCGTGAAGAAGAAAGGGCCAAGGCT
AAAGCAGAAGCTGAAGAATTGGTTAAGGGCGGTGAGGTCAAACACGAAAACAAGATGTGCTCAAGGTTTCG
CAGTGAAAAATGGAGTCATTTCAAGGAGCATCAGGCCCTCTTGATGCGGATTGCCAAGTGTGTAATCCTG
TACCTGGTGATCCTATTTGACGGCTACATTACCAAAGGGCGTGGCATTGCGATTACAGATCGGACTGTTCAT
AACATTAAGAGTCAAGATGGCTACCAAGAAGCTTGATTTGAGGTCGAGTGGGATTTGGACAATTCGAGTAA
AGATTATCAGGCTGAAATGATATCTATGGGCTCAATCGTAGTGGTCTGCTTAATGATGTGCTCCAAATTT
TATCAAACTCAACCAAGAGCATATCGACAGTCAATGCTCAGTCGACCAAGGACATGAAGTTTGCTAATATT
CACGTGAGCTTTGGCATTCCAAATCTGACGCATCTGACCCTGTGTGCGAAAAATCAAGGCAGTTCAGAA
TGTTTATAGCGTGAAGCGGACCAATGGCTAA

SEQUENCE LISTING

SEQ ID NO: 51 amino acid sequence comprising GAS 504

MKTRIT~~ELLNIDYPIFQGGMAWVADGDLGAVSNAGGLGIIGGGNAPKEVVKANIDRVKAITDRPFGVNIM~~
 LLS~~PFADDIVDLVIEEGVKVVT~~TGAGNPGKYMERLHQAGIIVV~~VPVPSVALAKRMEKLGVDAVIAEGMEAG~~
 GHIGKLT~~MTMSLVRQVVEAVSIPVIAAGGIADGHGAAAAMFLGAEAVQIGTRFV~~VAKESNAHQNF~~KDKILAA~~
 KDID~~TVISAQVVGH~~PVRSIKN~~KLTSAYAKAEKAFLIGQKTATDI~~EEMGAGSLRHAVIEG~~DVVNGSVMAGQI~~
 AGLV~~RKEESCETILKDIYYGAARVIQNEAKRWQSVSIEK~~

SEQ ID NO: 52 polynucleotide sequence encoding GAS 504

ATGAAAACACGTATTACAGAATTACTTAATATTGATTACCCCATTTTCAAGGAGGAATGGCTTGGGTTGC
 TGATGGTGATTTAGCAGGTGCAGTTTCTAATGCTGGTGGTTTAGGCATTATAGGTGGTGGCAATGCTCCCA
 AAGAAGTCGTTAAAGCTAATATTGATCGTGTCAAAGCTATTACTGATAGACCTTTTGGGGTTAATATCATG
 CTTTTATCTCCTTTTGCCTGATGATATCGTTGATCTGGTCATTGAAGAAGGTGTTAAAGTAGTAACAACAGG
 CGCAGGAAATCCAGGAAAGTATATGGAAAGACTGCACCAGGCGGTATAATCGTTGTTCTGTTGCTCCCAA
 GCGTTGCGCTAGCCAAACGTATGGAAAGCTTGGGGTAGATGCTGTTATTGCTGAGGGTATGGAAGCTGGA
 GGACATATTGGCAAGTTAACGACTATGTCTTTAGTAAGACAAGTTGTTGAAGCGGTTTTCGATTCTGTGCAT
 TGCGGCAGGTGGTATAGCTGATGGTCAATGGTGCAGCAGCAGCATTATGTTAGGAGCAGAGGCTGTTCAA
 TTGGAACTCGCTTTGTTGTTGCTAAAGAATCCAATGCTCACCAAAATTTAAAGATAAAATCTTAGCAGCA
 AAAGATAATTGATACGGTGATTTCTGCGCAGGTGTGGGCCACCCGTCCGTTCTATTAAAAATAAATGAC
 CTCAGCTTACGCTAAAGCAGAAAAAGCATTTTTAATTGGTCAAAAAACAGCTACTGATATTGAAGAAATGG
 GAGCAGGATCGCTTCGACACGCTGTTATTGAAGGCGATGTAGTCAATGGATCTGTTATGGCTGGCCAAAT
 GCAGGGCTTGTGAGAAAAGAAGAAAGCTGTGAAACGATTTTAAAGATATTTATTATGGTGCAGCTCGTGT
 TATCAAATGAAGCTAAGCGCTGGCAATCTGTTTCAATAGAAAAGTAG

SEQ ID NO: 53 amino acid sequence comprising GAS 509

MTKIYKTITELVGQTP~~IIKLNRLIPNEAADVYVKLEAFNPGSSVKDRIALSMIEAAEAEGLISPGDVII~~EP
 TSGNTGIGLAWVGAAGYR~~VIIVMPETMSLERRQIIQAYGAELVLT~~PGAEGMKGAIKAETLAI~~ELGAW~~
 MPMQFNNPANPSIHEKTTAQEILEAFKEISLDAFVSGVGTGGT~~LSGVSHVLKKNP~~ETVIYAVEAESAV
 LSGQEPGPHKIQGISAGFI~~PNTLDTKAYDQII~~RVKSKDALETARLTGAKEGFLVGISSGAALYAAIEVAK
QLGKGK~~HVLTILPDNGERYLSTELYDVPVIKTK~~

SEQ ID NO: 54 polynucleotide sequence encoding GAS 509

ATGACTAAAATTTACAAAACATAACAGAAATTAGTAGGTCAAACACCTATTATCAAACCTTAAACCGTTTAA
 TTCCAAACGAAGCTGCTGACGTTTATGTAATAATTAGAAGCTTTTAAACCCAGGATCTTCTGTAAAGATCG
 TATTGCTTTATCGATGATTGAAGCTGCTGAAGCTGAAGGTCTGATAAGTCTGGTGCAGTTATTTATCGAA
 CCAACAAGTGGTAATACAGGTATTGGTCTTGCAATGGGTAGGTGCTGCTAAAGGGTATCGAGTCATTATTG
 TTATGCCCGAAACTATGAGCTTGGAAAGACGGCAAATCATTGAGGCTTATGGTGCAGAGCTTGTCTTAA
 ACCTGGAGCAGAAGGTATGAAAGGGGCTATTGCAAAAGCTGAAACTTTAGCAATAGAACTAGGTGCTTGG
 ATGCCTATGCAATTTAATAACCCTGCCAATCCAAGCATCCATGAAAAACAACAGCTCAAGAAATTTTGG
 AAGCTTTTAAAGGAGATTTCTTTAGATGCATTCGTATCTGGTGTGGTACTGGAGGAACACTTTCGGTGT
 TTCACATGTCTTGA AAAAAGCTAACCCCTGAAACTGTTATCTATGCTGTTGAAGCTGAAGAATCTGCTGTC
 TTATCTGGTCAAGAGCCTGGACCACATAAAATTC AAGGTATATCAGCTGGATTTATCCCAAACACGTTAG
 ATACCAAAGCCTATGACCAAATTAFCGTGTTAAATCGAAAGATGCTTTAGAAACTGCTCGACTAACAGG
 AGCTAAGGAAGGCTTCTTGGTGGGATTTCTTCTGGAGCTGCTCTTACGCCGCTATTGAAGTCGCTAAA
 CAGTTAGGAAAAGGCAAACATGTGTTAACTATTTTACCAGATAATGGCGAACGCTATTTATCGACTGAAC
TCTATGATGTACCAGTAATTAAGACGAAATAA

SEQ ID NO: 55 amino acid sequence comprising C-terminus transmembrane region of GAS 509

FLVGISSGAALYAAIEVAKQLGKGK~~HVLTILPDNGERYLSTELYDVPVIKTK~~

SEQ ID NO: 56 amino acid sequencing comprising a fragment of GAS 509 where the C-terminal transmembrane region is removed

MTKIYKTITELVGQTP~~IIKLNRLIPNEAADVYVKLEAFNPGSSVKDRIALSMIEAAEAEGLISPGDVII~~EP
 TSGNTGIGLAWVGAAGYR~~VIIVMPETMSLERRQIIQAYGAELVLT~~PGAEGMKGAIKAETLAI~~ELGAW~~MP

SEQUENCE LISTING

MQFNPNANPSIHEKTTAQEILEAFKEISLDAFVSGVGTGGTSLGVS HV LKKNPETVIYAVEAEESAVLSG QEPGPHKIQGISAGFI PNTLDTKAYDQI IRVKS KDALETARLTGAKEG

SEQ ID NO: 57 amino acid sequence comprising GAS 366

MKVISNFQNKKILILGLAKSGEAAAKLLTKLGALVTVNDSKPFQNPAAQALLEEGIKVICGSHPV ELLDENFEYMVKNPGIPYDNPMVKRALAKEIPILTEVELAYFVSEAPIIGITGSNGKTTTTMIADVLNAGGQSAL LSGNIGYPASKVVQKAIAGDTLVME LSS FQLVGVNAFRPHIAVITNLMPTHLDYHG SFEDYVAAK WMIQAQMTESDY LILNANQEI SATLAKTTKATV I PFSTQKVVDGAYLKD GILYFKEQAI IAATDLGVP GSHNIENALATI AVAKLSGIADDIIAQCLSHFGGVKHLRQRVGQIKDITFYNDSKSTNILATQKALSGFDNSRLILIAGGLDRGNEFDDLVPDLLGLKQMIILGESAEERMKRAANKAEVSYLEARNVAEATELAFKLAQTGDTILLSPANASWDMYPNFEVRGDEFLATFDCLRGDA

SEQ ID NO: 58 polynucleotide sequence encoding GAS 366

ATGAAAGTGATAAGTAATTTTCAAACAAAAAATATTAATATTGGGGTTAGCCAAATCGGGCGAAGCAGCAGCAAAATTTATTGACCAAACTTGGTGCCTTAGTGACTGTTAATGATAGTAAACCATTTGACCAAAATCCAGCGGCACAAGCCTTGTGGAAGAGGGGATTAAGGTCATTTGTGGTAGCCACCCAGTAGAATTATTAGATGAGAACTTTGAGTACATGGTTAAAAACCTGGGATTCCTTATGATAATCCTATGGTTAAACCGGCCCTTGCAAAAGAAATCCCATCTTGACTGAAGTAGAATTGGCTTATTTGATCTGAAGCGCCTATTATCGGGATTACAGGATCAAACGGGAAGACAACCACAACGACAATGATTGCCGATGTTTGAATGCTGGCGGGCAATCTGCACTCTTATCTGGAAACATGGTTATCCTGCCTCAAAGTTGTTCAAAGCAATTGCTGGTGATACTTTGGTGATGGAAATGTCCCTTTTCAATTAGTGGGAGTGAATGCTTTTCGCCCTCATATGCTGTCTACTACTAATTTAATGCGGACTCACCTGGACTATCATGGCAGTTTTGAGGATTATGTTGCTGCTAAATGGATGATTCAAGCTCAGATGACAGAACTCAGACTACCTTATTTTAAATGCTAATCAAGAGATTCAGCAACTCTAGCTAAGACCACCAAAGCAACAGTGATTCCTTTTCAACTCAAAAAGTGGTTGATGGAGCTTATCTGAAGGATGGAATACTCTATT TAAAGAACAGGCGATTATAGCTGCAACTGACTTAGGTGTCCAGGTAGCCACAACATTGAAAATGCCCTA GCAACTATTGCAGTTGCCAAGTTATCTGGTATTGCTGATGATATFATTGCCAGTGCCTTTACATTTTGGAGCGTTAAACATCGTTTGCAACGGGTTGGTCAAATCAAAGATATTACCTTCTACAATGACAGTAAGTCAACCAATATTTTAGCCACTCAAAAAGCTTTATCAGGTTTTGATAACAGTCGCTTGATTTTGATTGCTGGCGGTCTAGATCGTGGAATGAATTTGACGATTTGGTGCCAGACCTTTTAGGACTTAAGCAGATGATTATTTGGGAGAATCCGCAGAGCGTATGAAGCGAGCTGCTAACAAAGCAGAGGTCCTTATCTTGAAGCTAGAAATGTGGCAGAAGCAACAGAGCTTGCTTTAAGCTGGCCAAACAGGCGATACTATCTTGCTTAGCCCAGCCAATGCTAGCTGGGATATGTATCCTAATTTTGAAGTTTCGTGGGGATGAATTTTGGCAACCTTTGATTGTTTAAAGAGGAGATGCCTAA

SEQ ID NO: 59 amino acid sequence comprising N-terminal leader sequence of GAS 366

MKVISNFQNKKILILGLAKSGEAAA

SEQ ID NO: 60 amino acid sequence comprising a fragment of GAS 366 where the N-terminal leader sequence is removed

KLLTKLGALVTVNDSKPFQNPAAQALLEEGIKVICGSHPV ELLDENFEYMVKNPGIPYDNPMVKRALAKEIPILTEVELAYFVSEAPIIGITGSNGKTTTTMIADVLNAGGQSAL LSGNIGYPASKVVQKAIAGDTLVME LSS FQLVGVNAFRPHIAVITNLMPTHLDYHG SFEDYVAAK WMIQAQMTESDY LILNANQEI SATLAKTTKATV I PFSTQKVVDGAYLKD GILYFKEQAI IAATDLGVP GSHNIENALATI AVAKLSGIADDIIAQCLSHFGGVKHLRQRVGQIKDITFYNDSKSTNILATQKALSGFDNSRLILIAGGLDRGNEFDDLVPDLLGLKQMIILGESAEERMKRAANKAEVSYLEARNVAEATELAFKLAQTGDTILLSPANASWDMYPNFEVRGDEFLATFDCLRGDA

SEQ ID NO: 61 amino acid sequence comprising GAS 159

MRKLYSFLAGVLGVIVILTSLSFILQKKS GSGSQSDKLV IYNWGDYIDPALLKKFTKETGIEVQYETFDSEN EAMYTKIKQGGTTYDIAVPSDYTIDKMIKENLLNKLDKSKLVGMDNIGKEFLGKSFDPQNDYSLPYFWGTV GIVYNDQLVDKAPMHWEDLWRPEYKNSIMLIDGAREMLGVGLTTFGYSVNSKNLEQLQAAERKLQQLTPNV KAI VADEMKG YMIQGDAAIGITFSGEASEMLDSNEHLHYIVPSEGSNLWFDNLVLPKTMKHEKEAYAF LNF INRPENAAQNAAYIGYATPNKKAKALLPDEIKNDPAFYPTDDI IKKLEVYDNLGSRWLGIYNDLYLQFKMYRK

SEQUENCE LISTING

SEQ ID NO: 62 polynucleotide sequence encoding GAS 159

ATGCGTAAACTTTATTCCTTTCTAGCAGGAGTTTTGGGTGTTATTGTTATTTTAACAAGTCTTTCTTTCAT
CTTGCGAGAAAAAATCGGGTCTGGTAGTCAATCGGATAAATTAGTTATTTATAACTGGGGAGATTACATTG
ATCCAGCTTTGCTCAAAAAATTCACCAAAGAAACGGGCATTGAAGTGCAGTATGAAACTTTGATTCCAAT
GAAGCCATGTACACTAAAATCAAGCAGGGCGGAACCATTACGACATTGCTGTTCTAGTATTACACCAT
TGATAAAATGATCAAAGAAAAACCTACTCAATAAGCTTGATAAGTCAAATTAGTTGGCATGGATAATATCG
GGAAAGAATTTTTAGGGAAAAAGCTTTGACCCACAAAACGACTATTCCTTTGCCTTATTTCTGGGGAAACCGTT
GGGATTGTTTATAATGATCAATTAGTTGATAAGGCGCCATGCACTGGGAAGATCTGTGGCGTCCAGAATA
TAAAAATAGTATTATGCTGATTGATGGAGCGCGTGAAATGCTAGGGGTTGGTTAACAACCTTTGGTTATA
GTGTGAATTTCAAATACTAGAGCAGTTGCAGGCAGCCGAGAGAAAACTGCAGCAGTTGACGCCGAATGTT
AAAGCCATTGTAGCAGATGAGATGAAAGGCTACATGATTCGAAGGTGACGCTGCTATTGGAATTACCTTTTC
TGGTGAAGCCAGTGAGATGTTAGATAGTAACGAACACCTTCACATACATCGTGCCTTCAGAAGGGTCTAACC
TTTGGTTTGATAATTTGGTACTACAAAAACCATGAAACACGAAAAAGAAGCTTATGCTTTTTTGAACCTTT
ATCAATCGTCTGAAAATGCTGCGCAAAATGCTGCATATATTGGTTATGCGACACCAAATAAAAAAGCCAA
GGCCTTACTTCCAGATGAGATAAAAAATGATCCTGCTTTTTATCCAACAGATGACATTATCAAAAAATTGG
AAGTTTATGACAATTTAGGGTCAAGATGGTTGGGGATTTATAATGATTTATACCTCCAATTTAAAATGTAT
CGCAAATAA

SEQ ID NO: 63 amino acid sequence comprising N-terminal leader sequence of GAS 159
MRKLYSFLAGVLGVIVILTSLSPI

SEQ ID NO: 64 amino acid sequence comprising a fragment of GAS 159 where the N-terminal leader sequence is removed

LQKKS GSGS QSDKLV IYNWGDYIDPALLKKFTKETGIEVQYETFD SNEAMYTKIKQGGTTYDIAVPSDYTI
DKMIKENLLNKLDKSKLVGMDNIGKEFLGKS FDPQNDYSLPYFWGTVGIVYNDQLVDKAPMHWEDLWRPEY
KNSIMLIDGAREMLGVGLTTFGYSVNSKNLEQLQAAERKLQQLTPNVKAI VADEMKG YMIQGDA AIGITFS
GEASEMLDSNEHLHYIVPSEGSNLWFDNLVLPKTMKHEKEAYAF LNF INRPENAAQNAAY IGYATPNKKAK
ALLPDEIKNDPAFYPTDDIIKKLEVYDNLGSRWLG IYNDLYLQFKMYRK

SEQ ID NO: 65 amino acid sequence comprising C-terminal hydrophobic sequence of GAS 159
WLG IYNDLYLQFKMYRK

SEQ ID NO: 66 amino acid sequence comprising a fragment of GAS 159 where the C-terminal hydrophobic region is removed

MRKLYSFLAGVLGVIVILTSLSPFILQKKS GSGS QSDKLV IYNWGDYIDPALLKKFTKETGIEVQYETFD SN
EAMYTKIKQGGTTYDIAVPSDYTI DKMIKENLLNKLDKSKLVGMDNIGKEFLGKS FDPQNDYSLPYFWGTV
GIVYNDQLVDKAPMHWEDLWRPEYKNSIMLIDGAREMLGVGLTTFGYSVNSKNLEQLQAAERKLQQLTPNV
KAI VADEMKG YMIQGDA AIGITFSGEASEMLDSNEHLHYIVPSEGSNLWFDNLVLPKTMKHEKEAYAF LNF
INRPENAAQNAAY IGYATPNKKAKALLPDEIKNDPAFYPTDDIIKKLEVYDNLGSR

SEQ ID NO: 67 amino acid sequence comprising a fragment of GAS 159 where the N-terminal leader sequence and the C-terminal hydrophobic region is removed

LQKKS GSGS QSDKLV IYNWGDYIDPALLKKFTKETGIEVQYETFD SNEAMYTKIKQGGTTYDIAVPSDYTI
DKMIKENLLNKLDKSKLVGMDNIGKEFLGKS FDPQNDYSLPYFWGTVGIVYNDQLVDKAPMHWEDLWRPEY
KNSIMLIDGAREMLGVGLTTFGYSVNSKNLEQLQAAERKLQQLTPNVKAI VADEMKG YMIQGDA AIGITFS
GEASEMLDSNEHLHYIVPSEGSNLWFDNLVLPKTMKHEKEAYAF LNF INRPENAAQNAAY IGYATPNKKAK
ALLPDEIKNDPAFYPTDDIIKKLEVYDNLGSR

SEQ ID NO: 68 amino acid sequence comprising GAS 217

MAQR IIVITGASGGLAQAI VQLPKEDSLILLGRN KERLEHCYQHIDNKECLELDITNPVAIEKMVAQIYQ
RYGRIDVLINNAGYGAFKGFEEFSAQEIADMFQVNTLASIHFA CLIGQKMAEQGQGH LINTVSMAGLIASA
KSSIYSATKFALIGFSNALRLELADKGVYVTTVNP GPIATKFFDQADPSGHYLESVGKFTLQPNQVAKRLV
SII GKNKRELNLPFSLAVTHQFYTLFPKLS DY LARKVFNYK

SEQ ID NO: 69 polynucleotide sequence encoding GAS 217

SEQUENCE LISTING

ATGGCACAAAGAATCATTGTTATCACGGGAGCTTCTGGAGGACTGGCTCAGGCAATTGTTAAGCAGTTACC
CAAGGAAGACAGCTTGATTTTATTAGGACGTAACAAAGAACGCCFAGAACACTGTTATCAGCATATTGACA
ACAAAGAATGCCTCGAGTTGGATATTACCAATCCAGTAGCCATTGAGAAAATGGTCGCCCAGATTTACCAG
CGCTATGGCCGTATTGATGTCTTGATTAATAATGCTGGCTACGGAGCTTTCAAAGGCTTTGAAGAGTTTTC
TGCCCAAGAAATAGCTGATATGTTTCAGGTTAACACCCCTAGCGAGCATTCAC'TTTCGTTGCTTGATTGGTC
AGAAAATGGCAGAGCAGGGGCAAGGTCACCTTATTAATAT'TGTGTCCATGGCAGGCTTGATTGCGTCAGCC
AAATCGAGCATT'TATTCAGCCACCAAGTTTGCCTTATCGGATTTTCCAATGCCCTTCGCTTAGAATTAGC
GGATAAAGGGGTTTACGTGACCACCGTGAATCCAGGTCCCATTGCCACCAAGTTTTTTTACCAGCTGACC
CGTCTGGACATTATTTGGAAAGCGTTGGTAAATTTACTCTCCAACCAATCAAGTGGCTAAGCGTTTGGTT
TCTATTATCGGGAAAATAAACGAGAATTGAATTTGCCCTTTAGTTTAGCGGTGACCCATCAATTTTACAC
CCTTTTCCCTAAATTATCTGATTATCTTGCAAGAAAGGTATTTAATTATAAATGA

SEQ ID NO: 70 amino acid sequence comprising GAS 309

MIEKYLESSIESKQLIVLFFKTSYLPITEVAEKTGLTFLQLNHYCEELNAFFPGSLSMTIQKRMSCQFT
HPFKETYLYQLYASSNVLQLLAFLIKNGSHSRPLTDFARSHFLSNSSAYRMREALIPLLRNFELKLSKNKI
VGEERYRIRYLIALLYSKFGIKVYDLTQQDKNTIHSFLSHSSTHLKTS PWLSESF SYFDILLALSWKRHQS
VTIPQTRIFQQLKLFVYDSLKKS SHDI I ETYCQLNFSAGLDLYLYLIYITANNFSASLQWTFEHIRQYQ
LFEENDTFRLLLNPIIITLLPNLKEQKASLVKALMFFSKSFLFNLOHFI PETNLFVSPYYKGNQKLYTSLKL
IVEEWMAKLPGKRDNLNKHKHFHLFCHYVEQSLRNIQPPLVVVFVASF INAHL L TDSFPRYFSDKSIDFHSY
YLLQDNVYQIPDLKPDLVITHSQLIPFVHHELTKGLIAVAEISFDESILSIQELMYQVKEEFQADLTKQLT

SEQ ID NO: 71 polynucleotide sequence encoding GAS 309

TTGATAGAAAAATACTTGGAAATCATCAATCGAATCAAATGTGAGTTAATTGTCTTGT'TTTTAAAGACATC
TTATTTGCCAATAACTGAGGTAGCAGAAAAACTGGCTTAACCTTTTTTACAACATAACCATTATGTGAGG
AACTGAATGCCTTTTTCCCTGGTAGTCTGTCTATGACCATCCAAAAAGGATGATATCTTGCCAAATTACA
CATCTTTTAAAGAAACTTATCTTTACCAACTCTATGCATCATCTAATGTCTTACAATTACTAGCCTTTTT
AATAAAAAATGGTTCCCCTCTCGTCCCTTACGGATTTTGAAGAAGTCATTTTTTATCAAACCTCCTCAG
CTTATCGGATGCGGAAGCATTGATTCCTTTATTAAGAACTTTGAATTAAACTCTCTAAGAACAAAGATT
GTCGGTGAGGAATATCGCATCCGTACCTCATCGCTCTGCTATATAGTAAGTTTGGCATTAAAGTTTATGA
CTTGACGCAGCAAGACAAAAACACTATTCATAGCTTTTTATCCCATAGTTCCACCACCTTAAACCTCTC
CTTGGTTATCGGAATCGTTTCTTCTATGACATTTTATTAGCTTTATCGTGGAAGCGGCATCAATTTTCG
GTAACTATTCCCAAACCAGAAATTTTCAACAATTAAAAAACTTTTTGTCTACGATCTTTGAAAAAAG
TAGCCATGATATTATCGAAACTTACTGCCAACTAACTTTTTCAGCAGGAGATTTGGACTACCTCTATTTAA
TTTATATCACCAGTAATAATCTTTTGGCGAGCTTACAATGGACACCTGAGCATAATCAGACAATATTGTCAA
CTTTTGAAGAAATGATACTTTTCGCCGTGCTTTTAACTATCATCACTTTTACCTAACCTAAAAGA
GCAAAAGGCTAGTTTGTAGTAAAGCTCTTATGTTTTTTTTCAAATCATCTTGT'TTAAATCTGCAACATTTTA
TTCCTGAGACCAACTATTTCGTTTCTCCGTACTATAAAGGAAACCAAAAACTCTATACGTCCTTAAAGTTA
ATTGTGAAGAGTGGATGGCCAACTTCTTGGTAAGCGTGACTTGAACCATAAGCATT'TTCATCTTTTTTG
CCACTATGTGCGACAAAGTCTAAGAAATATCCAACCTCTTTAGTTGTTGTTTTCGTAGCCAGTAATTTTA
TCAATGCTCATCTCCTAACGGATTCTTTTCCAAGGTATTTCTCGGATAAAAGCATTGATTTTCATTCTAT
TATCTATTGCAAGATAATGTTTATCAAATTCCTGATTTAAAGCCAGATTTGGTCATCACTCACAGTCAACT
GATTCCTTTTGTTCACCATGAACCTTACAAAAGGAATTGCTGTTGCTGAAATATCTTTTGATGAATCGATTC
TGCTATCCAAGAATTGATGTATCAAGTTAAAGAGGAAAAATCCAAGCTGATTTAACCAAGCAATTAACA
TAA

SEQ ID NO: 72 amino acid sequence comprising GAS 372

MIQIGKLFAGRYRILKSIGRGMADVLYLANDLILDNEDVAIKVLRRTNYQTDQVAVARFQREARAMAELNHP
NIVAIRDIGEEGQQFLVMEYVDGADLKRYIQNHAPLSNNEVVRIMEEVL SAMTLAHQKGI VHRDLKPQNI
LLTKEGVVKTDFGLIAVFAETSLTQTN SMLGSVHYLSPEQARGSKATI QSDIYAMGIMLFEMLTGHI PYD
GDSAVTIALQHFQKPLPSII EENHNVPQALENVVIRATAKKLSDRYGSTFEMSRDLMTALSYNRSRERKII
FENVESTKPLPKVASGPTASVKLSPPTPTVL TQESRLDQTNQTDALQPPTK KKSGRFLGTLFKILFSFFI
VGVALFTYLILTKPTSVKVPNVAGTSLKVAKQELYDVGLKVGKIRQIESDTVAEGNVVTRDPKAGTAKRQG
SSITLYVSI GNKFDMEYKGLDYQEAMNSLIETYGVPKSIIKIERIVTNEY PENTVI SQSPSAGDKFNPN
GKSKITLSVAVSDTTIMPMVTEYSYADAVNTLTALGIDASRIKAYVPS SSSATGFVPIHSPSSKAI VSGQS
PYYGTSLSLSDKGEISLYLYPEETHSSSSSSSSSTSSSNSSSINDSTAPGSNTELSPSETTSQTP

SEQUENCE LISTING

SEQ ID NO: 73 polynucleotide sequence encoding GAS 372

ATGATT CAGATT GGCAAAT TATTTGCTGGTCGTTATCGCATTCTGAAATCTATTGGCCGCGGTGGTATGGC
GGATGTTTATTTAGCAAATGACTTGATCTTGGATAATGAAGACGTTGCAATCAAGGTCTTGGCTACCAATT
ATCAAACAGATCAGGTAGCAGTTGCGCGTTTCCAACGAGAAGCGCGGGCCATGGCTGAATTGAACCATCCC
AATATTGTTGCCATCCGGGATATAGGTGAAGAAGACGGACAGCAATTTT TAGTAATGGAATATGTGGATGG
TGCTGACCTAAAGAGATACATTCAAAATCATGCTCCATTATCTAATAATGAAAGTGGTTAGAATTATGGAAG
AAGTCCTTTCTGCTATGACTTTAGCCCACCAAAAAGGAATGTACACAGAGATTTAAAACCTCAAAAATATC
CTACTAACTAAGGAGGGTGTGTCAAAGTAAC TGATTTCCGCGATCGCAGTAGCCTTTGCAGAAAACAAGCTT
GACACAACTAATTCGATGTTAGGCAGTGTTCATTACTTGTCTCCAGAACAGGCTCGCGGCTCCAAAGCGA
CGATTCAAAGTGATATTTATGCGATGGGGATTATGCTCTTTGAGATGTTGACAGGCCATATCCCTTATGAC
GGCGATAGTGCTGTACGATTGCCTTGCAACATTTTCAAAGCCTCTTCCATCTATTATCGAGGAGAACCA
CAATGTGCCACAAGCTTTGGAGAATGTTGTTATTCGAGCAACAGCCAAGAAATTAAGTGATCGTTACGGGT
CAACCTTTGAAATGAGTCGTGACTTAATGACGGCGCTTAGTTATAATCGTAGTCGGGAGCGTAAGATTATC
TTTGAGAATGTTGAAAGTACCAAACCCCTCCCCAAAGTGGCCTCAGGTCCCACCGCTTCTGTAAAATTGTC
TCCCCCTACCCCAACAGTGTAAACACAGGAAAGTCGATTAGATCAAAC TAATCAAACAGATGCTTTACAGC
CCCCACCAAAAAGAAAAAAGTGGTCGTTTTTTAGGTACTTTATTCAAATTTCTTTTTCTTTCTTTATT
GTAGGTGATGCACTCTTACTTATCTTTATCTTATACTAACTAAACCAACTTCTGTGAAAGTTCCTAATGTAGCAGG
CACTAGTCTTAAAGTTGCCAAACAAGAACTGTATGATGTTGGCTAAAAGTGGGTAAAATCAGGCAAAATG
AGAGTGATACGGTTGCTGAGGGAAATGTAGTTAGAACAGATCCTAAAGCAGGAACAGCTAAGAGGCAAGGC
TCAAGCATTACGCTTTATGTGTCAATGGAAACAAAGGTTTTGACATGGAAAAC TACAAAAGGACTAGATTA
TCAAGAAGCTATGAATAGTTTGATAGAACTTATGGTGTCCAAAATCAAATCAAATGAGCGCATTG
TAACTAATGAATATCCTGAAAATACAGTCATCAGTCAATCGCCAAGTGC GGGTGATAAATTTAATCCAAAC
GGAAAGTCTAAAATTACGCTCAGTGTGCTGTTAGTGATACGATCACTATGCC TATGGTAAACAGAAATATAG
TTATGCAGATGCAGTCAATACCTTAACAGCTTTAGGTATAGATGCATCTAGAATAAAAAGCTTATGTGCCAA
GCTCTAGCTCAGCAACGGGCTTTGTGCCAATTCATCTCCTAGTTCTAAAGCTATTGTCAGTGGTCAATCT
CCTTACTATGGAACGCTTTGAGTCTGTCTGATAAAGGAGAGATTAGTCTTTACCTTTATCCAGAAGAAAC
ACACTCTTCTAGTAGCTCATCGAGTTC AACGTCAAGTTCAAACAGTTCTTCAATAAATGATAGTACTGCAC
CAGGTAGCAACACTGAATTAAGCCCATCAGAACTACTTCTCAAACACCTTAA

SEQ ID NO: 74 amino acid sequence comprising GAS 39

MDLILFLLVLVLLGLGAYLLFKVNLQHQLAQTLQEGNADNLS DQMTYQLDTANKQQLLELTQLMNRQQAGL
YQQLTDIRDVLHRSLSDSRDRSDKRLEKINQVNVSLKMNQESNEKRLEKMRQIVEEKLEETLKNRHLASF
DSVSKQLESVNVKGLGEMRSVAQDVGTLNKVLNNTKTRGILGELQLGQI IEDIMTSSQYEREFVTVSGSSER
VEYAIKLPNGQGGYIYLPIDSKFPLEDYRLEDAYEVGDKLAI EASRKALLAAIKRFKDIHKKYLNPPPE
TTNFGVMFLPTEGLYSEVVRNASFFDSLREENIVVAGPSTLSALLNLSVGFKFLNIQKNADDISKILGN
VKLEFDKFGGLLAKAQKQMNNTANNTLDQLI STRTNAIVRALNTVETYQDQATKSLNMPLEEBENNEN

SEQ ID NO: 75 polynucleotide sequence encoding GAS 39

ATGGACCTTATCTTGTTCCTTTTGGTCTTGGTTCTCTTAGGTTTAGGGCTTATCTGTTGTTCAAAGTCAA
CGGCCTTCAACATCAGCTTGCCCAAACCTTAGAAGGCAACGCGGATAAATTTGCTGACCAAATGACCTACC
AGTTGGATACAGCTAACAAACAACATTTGTTAGAGCTAACACAGCTGATGAACCGACAACAAGCAGGCCTT
TACCAACAATTAACAGATATTCGTGACGCTTGCACCGTAGTTTGTCTGATAGTAGGGACCGGCTTGACAA
ACGCTTAGAAAAAATTAACCAGCAGGTCAACCAATCGCTCAAAAATATGCAAGAATCTAACGAAAAACGTT
TGGAGAAAATGCCCCAGATCGTTGAAGAAAAATTGGAAGAAACCTTAAAAAATCGTCTGCACGCCCTTTTC
GATTCTGTATCCAAGCAACTAGAAAGTGTCAATAAAGGCTTGGGAGAAATGCGTAGCGTGGCTCAAGATGT
GGGTACTTTAAATAAGGTTTTGTCCAATACCAAACACGAGGCATTTTAGGCGAACTTCAACTAGGCCAAA
TCATTGAGGATATCATGACATCAAGCCAGTACGAAAGAGAATTTGTAACGGTTAGTGGTTCTAGTGAACGC
GTAGAATATGCGATTAAGCTCCAGGAAATGGTCAAGGCGGTTATATTTACCTACCGATTGACTCAAATTT
CCCTCTTGAAGATTATACCGATTAGAAGATGCTTACGAAGTTGGTGATAAACTGGCCATCGAGGCTAGCC
GAAAAGCACTTCTGGCAGCTATCAAACGCTTGGCAAAGACATTCATAAAAAGTACTTGAACCCCCCAGAG
ACGACCAATTTCCGAGTTATGTTCTTACCAACAGAAGGCTTTTATTTCAGAAAGTGGTCAGAAATGCGTCTTT
CTTTGATAGCCTTCGTCGGGAAGAAAAATTTGTGGTTGCAGGCCCTTCGACCTGTCTGCTTTGCTGAATT
CCTTATCTGTTGGTTTCAAGACCCTTAATATCCAAAAAATGCTGATGACATCAGTAAAATTTTAGGCAAT
GTCAAGTTAGAATTCGATAAATTTGGCGGCCTGCTTGGCAAAGGCTCAAAAACAAATGAATACAGCTAATAA
TACGCTGGATCAGCTCATTCAACAAGGACAAATGCCATTGTTTCGAGCCTTGAATACCGTTGAAACTTATC
AAGACCAAGCAACAAAATCTCTCTTGAACATGCCCTTATTAGAAGAGGAAAAATAATGAAAATTA

SEQUENCE LISTING

SEQ ID NO: 76 amino acid sequence comprising GAS 42

MTKEKLVAFSQAHAEPAWLQERRLAALAEI PNLLELPTIERVKFHRWNLGDGTLTENESLASVPDFIAIGDN
 PKLVQVGTQTVLEQLPMALIDKGVVFSDFYTALEIPEVI EAHFGQALAFDEDEKLAAYHTAYFN SAAVLYV
 PDHLEITTPIEAIFLQSDSDVFPNKHVLVIAGKESKFTYLERFESIGNATQKISANISVEVIAQAGSQIK
 FSAIDRLGPSVTTYISRRGRLEKDANIDWALAVMNEGNVIADFDSDLIGQGSQADLKVVAASSGRQVQID
 TRVTNYGQRTVGHILQHGVLIRGTLTFNGIGHILKDAKGADAQQESRVLMLSDQARADANPILLIDENEV
 TAGHAASIGQVDPEDMYLMSRGLDQETAERLVIRGFLGAVIAEIPISVRQEI IKVLDEKLLNR

SEQ ID NO: 77 polynucleotide sequence encoding GAS 42

ATGACAAAAGAAAACTAGTGGCTTTTTTCGCAAGCCCACGCTGAGCCTGCTTGGCTGCAAGAACGGCGTTT
 AGCGGCATTAGAAGCCATTCCAAATTTGGAATTACCAACCATCGAAAGGGTTAAATTTACCGTTGGAATC
 TAGGAGATGGTACCTTAACAGAAAATGAAAGTCTAGCTAGTGTTCAGATTTTATAGCTATTGGAGATAAC
 CCAAAGCTTGTTTCAGGTAGGCACGCAAAACAGTCTTAGAACAGTTACCAATGGCGTTAATTGACAAGGGAGT
 TGTTTTCAGTGATTTTTATACGGCGCTTGAGGAAATCCAGAAGTAATTGAAGCTCATTTTGGTCAGGCAT
 TAGCTTTTGTATGAAGACAACTAGCTGCCTACCACACTGCTTATTTTAAATAGCGCAGCCGTGCTCTACGTT
 CCTGATCACTTGGAATCACAACTCCTATTGAAGCTATTTTCTTACAAGATAGTGACAGTGCAGTTCCTTT
 TAACAAGCATGTTCTAGTGATTGCAGGAAAAGAAAGTAAGTTCACCTATTTAGAGCGTTTTGAATCTATTG
 GCAATGCCACTCAAAGATCAGCGCTAATATCAGTGTAGAAGTGATTGCTCAAGCAGGCAGCCAGATTAAA
 TTCTCGGCTATCGACCGCTTAGGTCCTTCAGTGACAACCTATATTAGCCGTGAGGACGTTTAGAGAAGGA
 TGCCAACATTGATTGGGCTTAGCTGTGATGAATGAAGCAATGTCATTGCTGATTTTGACAGTGATTTGA
 TTGGTCAGGGCTCACAACTGATTTGAAAGTTGTTGCAGCCTCAAGTGGTTCAGGTACAAGGTATTGAC
 ACGCGCTGACCAACTATGGTCAACGTACGGTCGGTCATATTTTACAGCATGGTGTGATTTTGGAACGTGG
 CACCTTAACGTTTAAACGGGATTTGGTCATATCTAAAAGACGCTAAGGGAGCTGATGCTCAACAAGAAAGCC
 GTGTTTTGATGCTTTCTGACCAAGCAAGAGCCGATGCCAATCCAATCCTCTTAATTGATGAAAATGAAGTA
 ACAGCAGGTGATGCAGCTTCTATCGGTCAGGTTGACCCTGAAGATATGTATTACTTGATGAGTGCAGGACT
 GGATCAAGAAAACAGCAGAACGATTGGTTATTAGAGGATTCTTAGGAGCGGTTATCGCTGAAAATTCCTATTC
 CATCAGTCCGCCAAGAGATTATTAAGGTTTTAGATGAGAAATTGCTTAATCGTTAA

SEQ ID NO: 78 amino acid sequence comprising GAS 58

MKWSGFMKTKSKRFLNLATLCLALLGTTLLMAHPVQAEVISKRDYMTFRFLGLDLEDDSANYPNLEARYKG
 YLEGYEKGLKGDIDIPERPKIQVPEDVQPSDHG DYRDGYEEGFGEGQHKRDPLETEAEDDSQGGRQEGRQGH
 QEGADSSDLNVEESDGLSVIDEVVGVIYQAFSTIWTYLSGLF

SEQ ID NO: 79 polynucleotide sequence encoding GAS 58

ATGAAATGGAGTGGTTTTATGAAAACAAAATCAAACGCTTTTTTAAACCTAGCAACCCTTTGCTTGGCCCT
ACTAGGAACAACCTTTGCTAATGGCACATCCCGTACAGGCGGAGGTGATATCAAAAAGAGACTATATGACTC
 GCTTCGGGTTAGGCGATTTAGAAGATGATTCAGCTAACTATCCTTCAAATTTAGAAGCTAGATATAAAGGA
 TATTTAGAGGGATATGAAAAGGCTTAAAAGGAGATGATATACCCGAACGGCCCAAGATTCAGGTTCTCTGA
 GGATGTTACCCATCTGACCATGGCGACTATAGAGATGGTTATGAGGAAGGATTTGGAGAAGGACAACATA
 AACGTGATCCATTAGAAACAGAAGCAGAAGATGATTCCAAGGAGGACGTC AAGAAGGACGTC AAGGACAT
 CAAGAAGGAGCAGATTC TAGTGATTTGAACGTTGAAGAAAGCGACGGTTTTGTCTGTTATTGATGAAGTAGT
 TGGAGTAATTTATCAAGCATTTAGTACTATTTGGACATACTTAAGCGGTTTGTCTAA

SEQ ID NO: 80 amino acid sequence comprising N-terminal leader sequence of GAS 58

MKWSGFMKTKSKRFLNLATLCLALLGTTLLMA

SEQ ID NO: 81 amino acid sequence comprising a fragment of GAS 58 where the N-terminal leader sequence is removed

HPVQAEVISKRDYMTFRFLGLDLEDDSANYPNLEARYKGYLEGYEKGLKGDIDIPERPKIQVPEDVQPSDHG
 DYRDGYEEGFGEGQHKRDPLETEAEDDSQGGRQEGRQGHQEGADSSDLNVEESDGLSVIDEVVGVIYQAFS
 TIWTYLSGLF

SEQ ID NO: 82 amino acid sequence comprising GAS 290

SEQUENCE LISTING

MKHILFIVGSLREGSFNHQLAAQAQKALEHQAVVSYLNWKDVPVVLNQDIEANAPLPVVDARQAVQSADAIW
 IFTPVYNF SIPGSVKNLLDWLSRALDLSPTGPSAIGGKVVTVSSVANGGHDQVFDQFKALLPFI RTSVAG
 EFTKATVNPDAWGTGRLEISKETKANLLSQAEALLAAI

SEQ ID NO: 83 polynucleotide sequence encoding GAS 290

ATGAAACATATTTTATTATTGTTGGCTCGCTTCGTGAAGGGTCTTTTAACCATCAATTAGCGGCTCAAGC
 ACAAAAAGCTCTGGAACATCAAGCAGTTGTATCTTACTTAAATTGGAAAGACGTTCCCTGTTTTGAATCAAG
 ATATCGAAGCTAATGCACCTTTACCAGTTGTTGACGCTCGTCAAGCTGTTTCAGTCAGCGGATGCTATCTGG
 ATTTTTACACCAGTTTACAACCTTCTCTATTCCAGGTTCTGTTAAAAACCTGCTAGACTGGGTTGTCTCGTGC
 TCTTGATTTGTCTGATCCGACGGGCCATCTGCTATTGGCGGTAAGGTGTTACGGTCTCTTCAGTTGCAA
 ATGGCGGGCATGATCAAGTATTTGATCAGTTTAAAGCACTATTGCCGTTTATCCGAACCTCAGTAGCAGGA
 GAGTTTACAAAAGCAACTGTGAATCCTGATGCCTGGGGAACAGGAAGGCTTGAGATTTCAAAGAGACAAA
 AGCAAACCTGCTATCTCAGGCAGAGGCTCTTTTAGCGGCTATTTAG

SEQ ID NO: 84 amino acid sequence comprising GAS 511

MTDVSRI LKEARDQRLTTLDYANLIFDDFMELHGDRHF SDDGAI VGGGLAYLAGQPVTVIGIQKGKNLQDN
 LARNFGQPNPEGYRKALRLMKQAEKFRPVVTF INTAGAY PGVGAEEERGQGEAI AKNLMEMSDLKVP I IAI
 I IGEGGSGGALALAVADQVWMLLENTMYAVLSPEGFASILWKDGSRA TEAEMLMKITAGELYKMGIVDRI IP
 EHG YFSS EIVDI IKANLIEQITSLQAKPLDQLLDERYQRFKY

SEQ ID NO: 85 polynucleotide sequence encoding GAS 511

ATGACAGATGTATCAAGAATTTTAAAAGAAGCGCGTGATCAAGGGCGTTTAAACAACCTTTGGATTACGCCAA
 CCTTATTTTCGATGACTTTATGGAAGTGCATGGCGATCGCCATTTTTCAGATGATGGTGCCATTGTAGGTG
 GCCTAGCTTATTTGGCGGGACAACCTGTTACGGTCATGTTGTTATCAAAAAGGTAAGAATTTACAGGATAAT
 TTGGCAAGGAATTTGGCCAGCCCAATCCAGAAGGTTATCGTAAAGCTTTGCGCCTTATGAAAACAGGCAGA
 AAAATTTGGACGACCAGTTGTTACGTTTATCAATACTGCAGGAGCCTATCCAGGTGTGGTGGCGAAGAAC
 GAGGACAGGGTGAAGGCTTGTGTTAAATTTGATGGAATGAGTGATCTCAAGGTTCCCATTTATCGCCATC
 ATTATTGGTGAAGGAGCCTGTTGGTGCATTAGCCTTAGCGGTTGCCGATCAGGTCTGGGTTGAAAA
 TACTATGTATGCGGTTCTTAGCC CAGAAGGCTTTGCTTCTATTTTATGGAAGGATGGTTCAAGGGCGACCG
 AGGCCGCTGAATTGATGAAAATCACAGCGGGTGAACCTACAAAATGGGAATAGTAGACCGTATTATTTCCA
 GAACATGGTTATTTTCAAGTGAATCGTTGACATCATCAAAGCTAACCTCATCGAACAAA TAACCAGTTT
 GCAAGCTAAGCCATTAGACCAATTATTAGATGAGCGCTACCAACGCTTTCGTAAATATTTAA

SEQ ID NO: 86 amino acid sequence comprising GAS 533

MAITVADI RREVKEKNVTF LRLMFTDIMGVMKNVEI PATKEQLDKVLSNKVMFDGSSIEGFVRINESDMYL
 YPDLDTWIVFPWGDENGAVAGL ICDIYTAEGKPFAGDPRGNLKRALKHMNEIGYKSFNLGPEPEFFLFKMD
 DKGNPTLEVNDNGGYFDLAPIDLADNTRREIVNLLTKMGFEVEASHHEVAVGQHEIDFKYADVLKACDNIQ
 IFKLVVKT IAREHGLYATFMAKPKFGIAGSGMHCNMSLFDNQNNAFYDEADKRGMLQSEDAYYFLGGLMK
 HAYNYTAITNPTVNSYKRLVPGYEAPVYVAVAGSNRSPLIRVPASRGMGTRLELRVSDPTANPYLALAVLL
 EAGLDGIINKIEAPEFVEANIYTMTEERNEAGIIDLPSTLHNALKALQKDDVVQKALGYHIYTNFLEAKR
 IEWSSYATFVSWQWEIDHYIHNY

SEQ ID NO: 87 polynucleotide sequence encoding GAS 533

ATGGCAATAACAGTAGCTGACATTCGTCGTGAAGTCAAAGAAAAAATGTAACGTTTCTTCGCTTGATGTT
 CACTGATATCATGGGCGTTATGAAAAATGTGGAGATTCCTGCAACTAAAGAACAGTTAGACAAAGTATTGT
 CTAACAAGGTTATGTTGATGGTTCATCTATCGAAGTTTGTACGGATCAATGAGTCAGATATGTACCTT
 TACCCCGATTTAGACACTTGGATTGTTTTTCCCTGGGGAGATGAAAATGGAGCAGTTGCAGGTTTAAATTTG
 TGATATTTATACAGCAGAAGGAAAGCCTTTTGCAGGAGATCCTAGAGGAAAATTTAAAAAGAGCCCTGAAAC
 ACATGAACGAGATCGGCTACAAATCATTTAATCTTGGACCAGAACCAGAATTTTCCCTTTTAAAGATGGAT
 GATAAAGGTAATCCGACACTTGAAGTTAACGATAATGGTGGTTATTTGATTTAGCGCCAATTGACTTAGC
 AGACAACACGCGCCGTGAAATTTGTAATATTTTAAACGAAAATGGGTTTGAAGTGGAAAGCTAGTCATCATG
 AAGTGGCTGTTGGTCAACATGAGATTGATTTTAAATATGCAGATGTTTGAAGCTTGTGATAATATTTCAA
 ATTTTAAAGCTAGTTGTA AAAACGATGCCCCTGAACATGGACTTTATGCTACTTTCATGGCTAAACAAA
 ATTTGGAATAGCTGGATCAGGGATGCACGTGAACATGTCTTTGTTTGAATACCAAGGTAATAATGCTTTTT
 ATGATGAAGCTGATAAGCGAGGGATGCAGTTATCAGAAGATGCTTATTATTCTTGGGAGGACTAATGAAG
 CATGCTTATAACTACTGCTATCACCTAACCTCAGTGAATTCTTATAAACGATTAGTTCCAGGTTATGA

SEQUENCE LISTING

GGCACCTGTTTATGTGCGCTTGGGCTGGAAGTAATCGTTCACCGCTTATCCGTGTTCCAGCATCACGTGGTA
 TGGGAACCGCTTTGGAGTTACGTTTCGGTTGATCCGACAGCTAATCCTTATTTAGCCTTGGCTGTTCTCTTG
 GAAGCTGGATTAGATGGTATCATTAAACAAAATTGAAGCTCCAGAACCCGTTGAAGCTAACATTTATACCAT
 GACAATGGAAGAACGAAATGAAGCAGGCATTATTGATTTGCCATCAACGCTTCATAATGCCTTAAAAGCTC
 TTCAAAAAGATGATGTGGTACAAAAGGCAC TAGGTTACCATATCTACACTAATTTCTTAGAAGCAAAACGA
 ATTGAATGGTCTTCTATGCAACTTTTGTTCCTCAATGGGAAATTGACCATTATATTCATAAATTATTAG

SEQ ID NO: 88 amino acid sequence comprising GAS 527

MTEISILNDVQKIIIVLDYGSQYNQLIARRIREFGVSELKSHKITAQELREINPIGIVLSGGPNSVYADNA
 FGIDPEIFELGIPILGICYGMLITHKLGGKVVPAQAGNREYGQSTLHLRETSKLFSGTPQEQLVLSHG
 DAVTEIPEGFHLVGDSDNCPYAAIENTEKNLYGIQFHPEVRHSVYGNLILKNFAISICGARGDWSMDFID
 MEIAKIRETVGDRKVLGLSGVDSSVVGVLQKAIQDQLTCIFVDHGLLRKDEGDQVMGMLGGKFLNII
 RVDASKRFLDLLADVEDPEKKRKIIGNEFVYVDFDEASKLKGVDFLAQGTLYTDIIESGTEAQTIKSHHN
 VGGLPEDMQFELIEPLNTLFKDEVRLGIALGMPEEIVWRQFPGPGLAIRVMGAITEEKLETVRES DAIL
 REEIAKAGLDRDVWQYFTVNTGVR.SVGMGDGRTYDYPIAIRAITSIDGMTADFAQLPVDLKKISTRIVN
 EVDHVNRIVYDITSKPPATVEWE

SEQ ID NO: 89 polynucleotide sequence encoding GAS 527

ATGACTGAAATTTCAATTTTGAATGATGTTCAAAAAATATCGTTCCTTGATTATGGTAGCCAGTACAATCA
 GCTTATTGCTAGACGTATTCGAGAGTTTGGTGTTCCTCCGAAC TAAAAGCCATAAAAATCACCGCTCAAG
 AACTTCGTGAGATCAATCCCATAGGTATCGTTTTATCAGGAGGGCC TAACTCTGTTTACGCTGATAACGCC
 TTTGGCATTGACCC TGAATCTTTGAACTAGGGATTCCGATTCCTTGGTATCTGTTACGGTATGCAATTAAT
 CACCCATAAATTAGGTGGTAAAGTTGTTCCCTGCTGGACAAGCTGGTAATCGTGAATACGGTCAGTCAACCC
 TTCATCTTCGTGAAACGTC AAAAT TATTTTCAGGCACACCTCAAGAACAAC TCGTTTGTATGAGCCATGGT
 GATGCTGTTACTGAAATTC CAGAAGGTTTCCACCTTGTGGAGACTCAAATGACTGTCCTTATGCAGCTAT
 TGAAAATACTGAGAAAAACCTTTACGGTATT CAGTTC CACCAGAAGTGAGACACTCTGTTTATGGAAATG
 ACATTTTAAAAACTTTGCTATATCAATTTGTGGCGCGCTGGTGAATTGGTCAATGGATAATTTTATTGAC
 ATGGAATGCTAAAATTCGTGAAACTGTAGGCGACTGTAAGTCTTCTAGGTCCTTCTGGTGGAGTTGA
 TTCTTCAGTTGTTGGTGTCTACTTCAAAAAGCTATCGGTGACCAATTAAC TGTATTTCTGTTGATCAGG
 GTCTTCTTCGTAAAGACGAGGGCGATCAAGTTATGGGAATGCTTGGGGCAAATTTGGCCTAAATATTATC
 CGTGTGGATGCTTCAAACGTTTCTTAGACCTTCTTGCAGACGTTGAAGATCCTGAGAAAAACGTAAAAT
 TATTGGTAATGAATTTGCTATGTTTTTGTATGATGAAGCCAGCAAAT TAAAAGGTGTTGACTTCCTTGCCC
 AAGGAACACTTTATACTGATATCATTGAGTCAGGAACAGAAACTGCTCAAACCATCAAATCACATACAAT
 GTGGGTGGTCTCCCCGAAGACATGCAGTTTGAATTGATTGAGCCCTTAAACACTCTTTTCAAAGATGAAGT
 TCGAGCGCTTGGAAATCGCTTGGAAATGCCTGAAGAAATGTTTGGCGCAACCATTTCCAGGTCCTGGAC
 TTGCTATCCGTGCTCATGGGAGCAATTACTGAAGAAAAACTTGA AACCGTTCGCGAATCAGACGCTATCCTT
 CGTGAAGAAATGCTAAGGCTGGACTTGACTGACGTGTGGCAATACTTTACAGTTAACACAGGTGCTCCG
 TTCTGTAGGCGTCATGGGAGATGGTCTGACTTATGATTATACCATCGCCATTCGTGCTATTACGTCTATTG
 ATGGTATGACAGCTGACTTTGCTCAACTTCTTGGGATGTCTTGAAAAAATCTCAACACGTATCGTAAAT
 GAAGTTGACCACGTTAACCGTATCGTCTACGACATCACAAGTAAACCACCCGCAACAGTTGAATGGGAATA
 A

SEQ ID NO: 90 amino acid sequence comprising GAS 294

MSQSTATYINVIGAGLAGSEAAAYQLAKRGI PVKLYEMRGVKATPQHKTTFNFAELVCSNSFRGDSL TNAVGL
 LKEEMRRLDSIIMRNGEANRVPAGGAMAVDREGYAESVTAELNHPLEVI RGEITEIPDDAITVIATGPL
 TSDALAEKIHALNGGDGFYFYDAAAPIIDKSTIDMSKYVTLKSRDYDKGEAAYLNC PMTKEEFMAFHEALTA
 EEAPLNAFEKEKYFEGCMPIEVMAKRGIKTMLYGPMPKPVGLEYPDDYTGPRDGEFKTPYAVVQLRQDNAAG
 SLYNIVGFQTHLKWGEQKRVFQMI PGLENA EFRVRYGVMHRNSYMDSPNLLTETFQSRSNPNLFFAGQMTGV
 EGYVESAAAGLVAGINAARLFKREELIFPQTTAIGSLPHYVTHADSKHFQPMNVNFGI I KELEGPRIRDK
 KERYEIASRALADLDTCLASL

SEQ ID NO: 91 polynucleotide sequence encoding GAS 294

TTGTCTCAATCAACTGCAACTTATATTAATGTTATTGGAGCTGGGCTAGCTGGTCTGAAAGCTGCCTATCA
 GATTGCTAAGCGCGGTATCCCCGTTAAATGTTATGAAATGCGTGGTGTCAAAGCAACACCCGCAACATAAAA
 CCACTAATTTTGGCGAATTGGTCTGTTCCAAC TCAATTCGTGGTGTATAGCTTAACCAATGCAGTCGGTCTT
 CTCAAAAGAAGAAATGCGCGGATTAGACTCCATTATTATGCGTAATGGTGAAGCTAACC GCGTACCTGCTGG

SEQUENCE LISTING

GGGAGCAATGGCTGTTGACCGTGAGGGGTATGCAGAGAGTGTCACTGCAGAGTTGGAAAAATCATCCTCTCA
 TTGAGGTCATTCGTGGTGAAATACAGAAATCCCTGACGATGCTATCACGGTTATCGCGACGGGACCGCTG
 ACTTCGGATGCCCTGGCAGAAAAAATCACGCGCTAAATGGTGGCGACGGATTCTATTTTTACGATGCAGC
 AGCGCCTATCATTGATAAATCTACCATTGATATGAGCAAGGTTTACCTTAAATCTCGCTACGATAAAGGCG
 AAGCTGCTTACCTCAACTGCCCTATGACCAAAGAAGAATTCATGGCTTTCATGAAGCTCTGACAACCGCA
 GAAGAAGCCCCGCTGAATGCCTTTAAAAAGAAAAGTATTTTGAAGGCTGTATGCCGATTGAAGTTATGGC
 TAAACGTGGCATTAAAACCATGCTTTATGGACCTATGAAACCCGTTGGATTGGAATATCCAGATGACATA
 CAGGTCCTCGCGATGGAGAAATTTAAAACGCCATATGCCGTCGTGCAATTGCCGTAAGATAATGCAGCTGGA
 AGCCTTTATAATATCGTTGGTTTCCAAACCCATCTCAAATGGGGTGAGCAAAAACCGCTTTTCCAAATGAT
 TCCAGGGCTTGAATAATGCTGAGTTTGTCCGCTACGGCGTCATGCATCGCAATTCCTATATGGATTACCAA
 ATCTTTTAAACCGAAACCTTCCAATCTCGGAGCAATCCAAACCTTTTCTTTGCAGGTCAGATGACTGGAGTT
 GAAGGTTATGTCGAATCAGCTGCTTACAGGTTTAGTAGCAGGAATCAATGCTGCTCGTTTGTTCAAAAGAGA
 AGAAGCACTTATTTTCCCTCAGACAACAGCTATTGGGAGTTTGCCTCATTATGTGACTCATGCCGACAGTA
 AGCATTTCACCAACATGAACGTCAACTTTGGCATCATCAAAGAGTTAGAAGGCCACGCATTTCGTGACAAA
 AAAGAACGTTATGAAGCTATTGCTAGTCGTGCTTTGGCAGATTTAGACACCTGCTTAGCGTCGCTTTAA

SEQ ID NO: 92 amino acid sequence comprising GAS 253

MPKKILFTGGGTVGHVTLNLILIPKFIKDGWEVHYIGDKNGIEHTEIEKSGLDVTFHAIATGKLRRYFSWQ
 NLADVFKVALGLLQSLFIVAKLRPQALFSKGGFVSVPPVVAAKLLGKPVFIHESDRSMGLANKIAYKFATT
 MYTTFEQEDQLSKVKHLGAVTKVFKDANQMPESTQLEAVKEYFSDRLKTLLEFIGGSAGAHVFNQFISDHPE
 LKQRYNIINITGDPHLNELSSHLRYVDYVTDLYQPLMAMADLVVTRGGSNTLFE LLAMAKLHLIVPLGKEA
 SRGDQLENATYFEKRGYAKQLQEPDLTLHNFQDAMADLFEHQADYEATMLATKEIQSPDFFYDLLRADISS
 AIKEK

SEQ ID NO: 93 polynucleotide sequence encoding GAS 253

ATGCCAAGAAGATTTTATTTACAGGTGGTGGAACTGTAGGTCATGTCACCTTGAACCTCATTCTCATACC
 AAAATTTATCAAGGACGGTTGGGAAGTACATTATATTGGTGATAAAAATGGCATTGAACATACAGAAATG
 AAAAGTCAGGCCCTTGACGTGACCTTTCATGCTATCGCGACAGGCAAGCTTAGACGCTATTTTTTCATGGCAA
 AATCTAGCTGATGTTTTTAAGGTTGCACTTGGCCTCCTACAGTCTCTCTTTATTTGTTGCCAAGCTTCGCCC
 TCAAGCCCTTTTTTCCAAAGGTGGTTTTGTCTCAGTACCGCCAGTTGTGGCTGCTAAATTGCTTGGTAAAC
 CAGTCTTTATTCATGAATCAGATCGGTCAATGGGACTAGCAAACAAGATTGCCCTACAAATTTGCAACTACC
 ATGTATACCACTTTTGAGCAGGAAGACCAGTTGTCTAAAGTTAAACACCTTGGAGCGGTGACAAAGGTTTT
 CAAAGATGCCAACCAATGCCTGAATCAACTCAGTTAGAGGCGGTGAAAGAGTATTTTAGTAGAGACCTAA
 AAACCTCTTGTTTATTTGTTGGTTCGGCAGGGCGCATGTGTTAATCAGTTTATTAGTGATCATCCAGAA
 TTGAAGCAACGTTATAATATCATCAATATTACAGGAGACCTCACCTTAATGAATTGAGTTCTCATCTGTA
 TCGAGTAGATTATGTTACCGATCTCTACCAACCTTTGATGGCGATGGCTGACCTTGTAGTGACAAGAGGGG
 GCTCTAATACACTTTTTGAGCTACTGGCAATGGCTAAGCTACACCTCATCGTTCCTCTTGGTAAAGAAGCT
 AGCCGTGGCGATCAGTTAGAAAATGCCACTTATTTTGAAGAAGAGGGGCTACGCTAAACAATTACAGGAACC
 TGATTTAACTTTGCATAATTTTATCAGGCAATGGCTGATTTGTTTGAACATCAGGCTGATTATGAGGCTA
 CTATGTTGGCAACTAAGGAGATTACAGTCACCGACTTCTTTTATGACCTTTTGGAGAGCTGATATTAGCTCC
 GCGATTAAGGAGAAGTAA

SEQ ID NO: 94 amino acid sequence comprising GAS 529

MCGIVGVGNRNATDILMQGLEKLEYRGYDSAGIFVANANQTNLIKSVGRIADLRAKIGIDVAGSTGIGHT
 RWATHGQSTEDNAHPHTSQTGRFVLVHNGVIENYLHIKTEFLAGHDFKQTDTEIAVHLIGKFVEEDKLSV
 LEAFKKSLSIIIEGSYAFALMDSQATDTIYVAKNKSPLLIIGLGEYNMVCSAMAMIRETSEFMEIHKELV
 ILTKDKVTVDYDGKELIRDSYTAELDLSDIGKGYPFYMLKEIDEQPTVMRQLISTYADETGNVQVDPAI
 ITSIQEADRLYILAAGTSYHAGFATKNMLEQLTDTPVELGVASEWGYHMPPLSKKPMFILLSQSGETADSR
 QVLVKANAMGIPSLTVTNVPSTLSREATYTMLIHAGPEIAVASTKAYTAQIAALAFKAVGEANGKQEA
 LDFNLVHELSELVAQSI EATLSEKDLVAEKVQALLATTRNAFYIGRNDYYVAMEAALKLKEISYIQCEGFA
 AGELKHGTISLIEEDTPVIALISSQLVASHTRGNIQEVAARGAHLTVVVEEGLDREGDDIIVNKVHPFLA
 PIAMVIPTQLIAYYASLQRLDVKPRNLAKAVTVE

SEQ ID NO: 95 polynucleotide sequence encoding GAS 529

ATGTGTGGAATTGTTGGAGTTGTTGGAAATCGCAATGCAACGGATATTTTAAATGCAAGGCCCTTGAAGGCT
 TGAATACCGGGGTTATGATTCAGCAGGAATTTTTGTGGCTAATGCCAATCAAACAAACTTGATTAATCAG

SEQUENCE LISTING

TGGGGCGGATTGCTGATTTGCGTGCCAAGATTGGCATTGATGTTGCTGGTTCAACAGGGATTGGTCACACC
 CGTTGGGCAACGCATGGCCAATCAACAGAGGATAATGCCCATCCTCACACGTCACAACTGGACGTTTTGT
 ACTTGTTCATAATGGTGTGATTGAAAATTACCTTCACATTAACAGAGTTCCTAGCTGGACATGATTTTA
 AGGGGCAGACAGATACTGAGATTGCAGTACACTTGATTGGAAAATTTGTGGAAGAAGACAAGTTGTCAGTA
 CTGGAAGCTTTTAAAAAATCTTTAAGCATTATTGAAGGTTCCACGCCTTTGCATTAATGGATAGCCAAGC
 AACTGATACTATTTATGTGGCTAAAAACAAGTCTCCATTGTTGATTGGACTTGGTGAAGGTTACAACATGG
 TTTGTTTCAGATGCCATGGCCATGATTTCGTGAAACCAGTGAATTTATGGAATTCATGATAAGGAGTAGTT
 ATTTTAACCAAAGATAAGGTAACGTGTTACAGACTACGATGGTAAAGAGCTGATACGAGATTCCTACACTGC
 TGAATTAGACTTATCTGATATTGGCAAAGGGACTTATCCTTTCTATATGCTGAAAGAAATTGATGAGCAAC
 CAACCGTAATGCGTCAATTAATTTCAACTTATGCAGATGAACTGGTAACGTACAGGTTGATCCGGCTATC
 ATTACCTCTATCCAAGAGGCTGACCGTCTTTATATTTTAGCGGCAGGGACTTCCTACCATGCTGGTTTTGC
 AACAAAAATATGCTTGAGCAATTGACAGATACACCAGTTGAGTTGGGCGTGGCTTCTGAGTGGGGTTACC
 ACATGCCTCTGCTTAGCAAGAAACCAATGTTTATCTACTAAGCCAATCAGGAGAAACCGCAGATAGTCGT
 CAAGTTTGTAGTAAAGGCAATGCTATGGGCATTCCGAGTTTGACAGTAACCTAACGTTCCAGGATCAACCTT
 ATCACGTGAAGCAACATACACCATGTTGATTTCATGCTGGACCTGAAATGCTGTTGCGTCTACAAAAGCTT
 ACCTGCACAAATTGCTGCCCTTGCCCTTTTGGCTAAGGCAGTTGGTGAGGCAATGGTAAGCAAGAAGCT
 CTTGACTTTAACTTGGTACATGAGTTGTCATTTGGTTGCCCAATCTATTGAGGCGACTTTGTCTGAAAAAGA
 TCTCGTGGCAGAAAAGGTTCAAGCTTTGCTAGCTACTACTCTGTAATGCTTTTTTACATCGGGCGTGGCAATG
 ATTATTACGTTGCGATGGAAGCTGCTTTGAAATTAAGAGATTTCCTTATATCAATGCGAAGGCTTTGCG
 GCTGGTGAATTGAAACATGGAACCATTTCAATTAATTGAGGAGGACACGCCAGTAATCGCTTTAATATCGTC
 TAGTCAGTTGGTTGCCCTCTCATACCGCTGTAATATCAAGAAGTTGCTGCCCGTGGGGCTCATGTTTTAA
 CAGTTGTGGAAGAAGGGCTTGACCGTGAGGGAGATGACATTATTGTCAATAAGGTTTCATCCTTTCTAGCC
 CCGATTGCTATGGTCATTCCAACCTCAACTGATTGCTTACTACGCTTCATTACAACGTGGACTTGATGTTGA
 TAAGCCACGTAATTTGGCTAAAGCTGTAACAGTAGAATAA

SEQ ID NO: 96 amino acid sequence comprising GAS 45

VTFMKKSKWLAAVSVAIVLSVSALAAACGNKNASGSEATKTYKVFVNDPKSLDYILTNGGGTTDVITQMVD
 GLEND EYGNLVP SLAKDWK VSKDGLTYTYTLRDG VSWYTADGEEYAPVTAEDFVTLGKHAVDDKSDALYV
 VEDSIKNLKAYQNGEVDFKEVGVKALDDKTVQYTLNKPESYWN SKTYSVLFV PNAKFLKSKGKDFGTTDP
 SSILVNGAYFLSAFTSKSSMEFHKNENYWDANKVGI ESVKLTYSDGSDPGSFYKNFNDKGEFSVARLYPNDP
 TYKS AKKNYADNITYGMLTGDIRHLTWNLNRTSFKNTKKDPAQQDAGKKALNNKDFRQAIQFAFDRASFQA
 QTAGQDAKTKALRNMLVPPFTFVTIGESDFGSEVEKEMAKLGDEWKDVNLADAQDGFYNPEKAKAEFAKAKE
 ALTAEGVTFPVQLDYPVDQANAATVQEAQSFQKSVEASLGKENVIVNVLETETSTHEAQGFYAETPEQQDY
 DIISSWGPDPYQDPRTYLDIMS PVGGG SVIQKLG I KAGQNKDVAAAGLDTYQTLLEAAAITDDNDARYK
 AYAKAQAYLTDNAVDI PVVALGGT PRVTKAVPFSGGF SWAGSKGPLAYKGMKLDQKPVTVKQYEKAKWKW
 KAKAKSNAKYAEKLADHVEK

SEQ ID NO: 97 polynucleotide sequence encoding GAS 45

GTGACTTTTATGAAGAAAAGTAAATGGTTGGCAGCTGTAAGTGTGCGATCTTGTGAGTATCCGCTTTGGC
AGCTTGTGGTAATAAAAATGCTTCAGGTGGCTCAGAAGCTACAAAAACCTACAAGTACGTTTTTGTAAACG
 ATCCAAAATCATTGGATTATATTTGACTAATGGCGGTGGAACGACTGATGTGATAACACAAATGGTTGAT
 GGTCTTTTGGAAAACGATGAGTATGGTAATTTAGTACCATCACTTGCTAAAGATTGGAAGGTTTCAAAGA
 CGGTCTGACTTATACTTATACTCTTCGCGATGGTGTCTCTTGGTATACGGCTGATGGTGAAGAATATGCC
 CAGTAACAGCAGAAGATTTTGTGACTGGTTTGAAGCAGCGGTTGACGATAAATCAGATGCTCTTTACGTT
 GTTGAAGATTCAATAAAAAAATTAAGGCTTACCAAATGGTGAAGTAGATTTTAAAGAAGTTGGTGTCAA
 AGCCCTTGACGATAAAAATGTTTCAGTATACTTTGAACAAGCCTGAAAGCTACTGGAATTCAAAAACAATTT
 ATAGTGTGCTTTTCCCAGTTAATGCGAAATTTTGAAGTCAAAGGTAAAGATTTTGGTACAACCGATCCA
 TCATCAATCCTTGTAAATGGTGCTTACTTCTTGAGCGCTTACCTCAAATCATCTATGGAATTCATAA
 AAATGAAAACCTACTGGGATGCTAAGAATGTTGGGATAGAATCTGTTAAATGACTTACTCAGATGGTTCAG
 ACCAGGTTTCGTTCTACAAGAACTTTGACAAGGGTGAGTTTCAGCGTTGCACGACTTTACCCAAATGACCC
 ACCTACAAATCAGCTAAGAAAACTATGCTGATAACATTACTTACGGAATGTTGACTGGAGATATCCGTC
 TTTAACATGGAATTTGAACCGTACTTCTTTCAAACACTAAGAAAGACCCGTCACAACAAGATGCCGGTA
 AGAAAGCTCTTAAACAACAAGGATTTTCGTCAGCTTACTAGTTGCTTTGACCGAGCGTCAATCCAAGCA
 CAACTGCAGGTC AAGATGCCAAAACAAGCCTTACGTAACATGCTTGTCCCAACAACATTTGTGACCAT
 TGGAGAAAGTGATTTTGGTTCAGAAGTTGAAAAGGAAATGGCAAACTTGGTGATGAATGGAAAAGACGTTA
 ACTTAGCTGATGCTCAAGATGGTTCTATAATCCTGAAAAGCAAAAGCTGAGTTTGCAAAAGCCAAAGAA

SEQUENCE LISTING

GCTTTAACAGCTGAAGGTGTAACCTTCCCAGTTCAATTAGATTACCCTGTTGACCAAGCAAACGCAGCAAC
 TGTTTCAGGAAGCCCAGTCTTTTCAAACAATCTGTTGAAGCATCTCTTGGTAAAGAGAATGTCATTGTCAATG
 TTC TTGAAACAGAAACATCAACTCACGAAGCCCAAGGCTTCTATGCTGAGACCCAGAACAAACAAGACTAC
 GATATCATTTCATCATGGTGGGGACCAGACTATCAAGATCCACGGACCTACCTTGACATCATGAGTCCAGT
 AGGTGGTGGATCTGTTATCCAAAACTTGAATCAAAGCAGGTCAAAAATAAGGATGTTGTGGCAGCTGCAG
 GCCTTGATACCTACCAAACCTTCTTGTGATGAAGCAGCAGCAATTACAGACGACAACGATGCGCGCTATAAA
 GCTTACGCAAAGCACAAGCCTACCTTACAGATAATGCCGTAGATATCCAGTTGTGGCATTGGGTGGCAC
 TCCACGAGTTACTAAAGCCGTTCCATTTAGCGGGGGCTTCTCTTGGGCAGGGTCTAAAGGTCTCTAGCAT
 ATAAAGGAATGAAACTTCAAGACAAACCTGTACAGTAAAAACAATACGAAAAAGCAAAGAAAAATGGATG
 AAAGCAAAGGCTAAGTCAAATGCAAATATGCTGAGAAGTTAGCTGATCACGTTGAAAAA

SEQ ID NO: 98 amino acid sequence comprising an N-terminal leader sequence of GAS 45
 VTFMKKSKWLAAVSVAILSVSALAA

SEQ ID NO: 99 amino acid sequence comprising a fragment of GAS 45 where the N-terminal
 leader sequence is removed

CGNKNASGGSEATKTYKYVFNNDPKSLDYILTNNGGTTDVITQMV DGLLENDEYGNLVP SLAKDWKVKSKDG
 LTYTYTLRDGVS WYTADGEEYAPVTAEDFVTGLKHAVDDKSDALYVVEDSIKNLKAYQNGEVDFKEVGVKA
 LDDKTQYTLNKPESYWNKTYTYSVLFVNAKFLKSKGKDFGTTDPSSILVNGAYFLSAFTSKSSMEFHKN
 ENYWDANKVGI ESVKLTYSDGSDPGSFYKNFDKGEFSVARLYPNDPTYKSAKKNYADNITYGMLTGDIRHL
 TWNLNRTSFKNTKKDPAQQDAGKKALNNKDFRQAIQFAFDRASFQAQTAGQDAKTKALRNMLVPPFTVTIG
 ESDFGSEVEKEMAKLGDWVKDNLADAQDGFYNPEKAKAEFAKAKEALTAEGVTFPVQLDYPVDQANAATV
 QEAQSFKQSV EASLGENVIVNVLETETSTHEAQQGYAETPEQQDYDIISSWWGPDYQDPRTYLDIMSPVG
 GGSVIQKLGIKAGQNKDVVAAAGLDTYQTLLEAAAAITDDNDARYKAYAKAQAYLTDNAVDI PVVALGGTP
 RVTKAVPFSGGFSWAGSKGPLAYKGMKLODKPVTVKQYKAKEKWMKAKAKSNAKYAEKLADHVEK

SEQ ID NO: 100 amino acid sequence comprising GAS 95

MKIGKKIVLMFTAIVLTTVLALGVYLTSAYTFSTGELSKTFKDFSTSSNKSDAIKQTRAFSILLMGVDTGS
 SERASKWEGNSDSMILVTNPKTKKTTMTSLERDTLTTLSGPKNNEMNGVEAKLNAAYAAGGAQMAIMTVQ
 DLLNITIDNYVQINMQGLIDLVNAVGGITVTNEFDFFPISIAENEPEYQATVAPGTHKINGEQALVYARMRY
 DDEPGDYGRQKRQREVIQKVLKILALDSISSYRKILSAVSSNMQTNIEISSRTIPSLGLYRDALRTIKTY
 QLKGEDATLSDGGSYQIVTSHLLEIQNRIRTELGLHKVNQLKTNAVYENLYGSTKSTQVNNNYDSSGQA
 PSYSDSHSSYANYSSGVDTGQSASTDQDSTASSHRPATPSSSSDALAADESSSSGSGSLVPPANINPQT

SEQ ID NO: 101 polynucleotide sequence encoding GAS 95

ATGAAAAATTGGAATAAATAAGTTTAAATGTTACAGCTATTGTGTTAAACAACCTGCTTTGGCATTAGGTGT
CTATCTAACTAGTGCCTTATACCTTCTCAACAGGAGAATTATCAAAGACCTTTAAAGATTTTTTCGACATCTT
 CAAACAAAAGTGATGCCATTAACAACAAGAGCTTTTTCTATCTTGTGATGGGTGTTGATACAGGCTCT
 TCAGAGCGTGCC TCCAAGTGGGAAGGAAACAGTGATTCGATGATTTTGGTTACGGTTAATCCAAAGACCAA
 GAAAACAACTATGACTAGTTTGAACGAGATACCTTAACCACGTTATCTGGACCCAAAAATAATGAAATGA
 ATGGTGTGTAAGCTAAGCTTAACGCTGCTTATGCAGCAGGTGGCGCTCAGATGGCTATTATGACCGTGCAA
 GATCTTTTGAATATCACCATTGATAACTATGTTCAAATTAATATGCAAGGCCATTATGATCTTGTGAATGC
 AGTTGGAGGGATTACAGTTACAAATGAGTTTGAATTTCTATCTCGATTGCTGAAAAACGAACCTGAATATC
 AAGCTACTGTTGCGCCTGGAACACACAAAATTAACGGTGAACAAGCTTTGGTTTATGCTCGTATGCGTTAT
 GATGATCCTGAGGGAGATTATGGTCGACAAAAGCCTCAACGTGAAGTCATTCAAAGGATTGAAAAAAT
 CCTTGCTCTTGATAGCATTAGCTCTTATCGGAAGATTTTATCTGCTGTAAGTAGTAATATGCAAACGAATA
 TCGAAATCTCTTCTCGCACTATCCCTAGTCTATTAGGTTATCGTGACGCACTTAGAACTATTAAGACTTAT
 CAACTAAAAGGAGAAGATGCCACTTTATCAGATGGTGGATCATACCAAATGTTACCTCTAATCATTTGTT
 AGAAATCCAAAATCGTATCCGAACAGAATTAGGACTTCATAAGGTTAATCAATTAACAAACAATGCTACTG
 TTTATGAAAATTTGTATGGGTCAACTAAGTCTCAGACAGTAAACAACAACATGACTCTTCAGGCCAGGCT
 CCATCTTATTCTGATAGTCATAGCTCTTACGCTAATTATTCAAGTGGAGTAGATACCGGCCAGAGTGCTAG
 TACAGACCAGGACTCTACTGCTTCAAGCCATAGGCCAGCTACGCCGCTTCTTCATCAGATGCTTTAGCAG
 CTGATGAGTCTAGCTCATCAGGGTCTGGATCATTAGTTCTCTCTGCTAATATCAACCTCAGACCTAA

SEQ ID NO: 102 amino acid sequence comprising N-terminal leader sequence of GAS 95
 MKIGKKIVLMFTAIVLTTVLALGVYLTSAYTF

SEQUENCE LISTING

SEQ ID NO: 103 amino acid sequence comprising a fragment of GAS 95 where the N-terminal leader sequence is removed.

TGELSKTFFKDFSTSSNKSDAIKQTRAFSILLMGVDTGSSSERASKWEGNSDSMILVTVPKTKKTTMTSLER
 DTLTTLSPKNNEMNGVEAKLNAAYAAGGAQMAIMTVQDLLNITIDNYVQINMQGLIDLVNAVGGITVTNE
 RFDFFISIAENEPEYQATVAPGTHKINGEQALVYARMRYDDPEGDYGRQKRQREVIQKVLKILALDSISSY
 RKILSAVSSNMQTNIEISSRTIPSLGKYRDLRTIKTYQLKGEDATLSDGGSYQIVTSNHLLLEIQNRIRTE
 LGLHKVNQLKTNATVYENLYGSTRKSTQTVNNNYDSSGQAPSYSDSHSSYANYSSGVDTGQSASTDQDSTASS
 HRPATPSSSSDALAADESSSSGSGSLVPPANINPQT

SEQ ID NO: 104 amino acid sequence comprising GAS 193

MKKRLLAVTLLSTILLNSAVPLVVADTSLRNSTSSDQPTTADTDTTDESETPKKDKKSKETASQHDQK
 DHKPSHTHTPPSNDTKQTDQASSEATDKPNKDKNDTKQPDSSDQSTPSPKQSSQKESQNKDGRPTSPD
 QQKQDTPDKTPEKSADKTPKGPPEKATDKTPEPNRDAPKPIQPPLAAAPVFI PWRESKDKLSKLPSSRSS
 AAYVRHWGTDSAYTHNLLSRRYGTAEQLDGLFNLGLIHYDKERLNGKRLLEWEKLTGLDVRAIVAIAMAE
 SSLGTQGVAKKGANMFGYGAFFNPNNAKKYSDEVAIRHMVEDTIIANKNQTFERQDLKAKKWSLGLQDLD
 LIDGGVYFTDTS GSGQRRADIMTKLDQWIDDHGSTPEIPEHLKITSGTQFSEVPVGYKRSQPQNVLTYSKSE
 TYSFGQCTWYAYNRVKELGYQVDRYMGNGGDWQRKPGFVTHKPKVGYVVSFAPGQAGADATYGHVAVVEQ
 IKEDGSILISESNVMGLGTISYRTFTAEQASLLTYVVGDKLPRP

SEQ ID NO: 105 polynucleotide sequence encoding GAS 193

ATGAAGAAAAGGAAATGTTAGCAGTAACACTATTAAGTACCATACTCTTAAACAGTGCAGTGCCATTAGT
 TGTTGCTGATACCTCCTTGCGTAATAGCACATCCTACTGATCAGCCTACTACAGCAGATACTGATACGG
 ATGACGAGAGTGAAACACCAAAAAAAGACAAAAAAGCAAGGAAACAGCGTCGCAGCAGACACCCAAAAA
 GACCATAAGCCATCACACACTCACCAACCCCTTCAAATGATACTAAGCAGACCGATCAGGCATCATC
 TGAAGCTACTGACAAACCAATAAAGACAAAAACGACACCAAGCAACCAGACAGCAGTGCATCAATCCACC
 CATCTCCCAAAGACCAGTCGTCCTCAAAAAGAGTCAAAAAACAAAGACGGCCGACCTACCCATCACCTGAT
 CAGCAAAAAGATCAGACACCTGATAAAACACCAGAAAAATCAGCTGATAAAACCCCTGAAAAAAGGACCAGA
 AAAAGCAACTGATAAAACACCAGAGCCAAATCGTGACGCTCCAAAACCCATCCAACCTCCTTTAGCAGCTG
 CTCCTGTCTTTATACCTTGGAGAGAAAGTGACAAAGACCTGAGCAAGCTAAAACCAAGCAGTCGCTCATCA
 GCGGCTTACGTGAGACACTGGACAGGTGACTCTGCCTACACTCACAACCTGTTGTCAGCCGTTATGGGAT
 TACTGCTGAACAGCTAGATGGTTTTTTGAACAGTCTAGGTATTCATATGATAAAGAACGCTTAAACGGAA
 AGCGTTTTATTAGAATGGGAAAAACTAACAGGACTAGACGTTTCGAGCTATCGTAGCTATTGCAATGGCAGAA
 AGCTCACTAGGTACTCAGGGAGTTGCTAAAGAAAAGGAGCCAAATATGTTTGGTTATGGCGCCTTTGACTT
 CAACCCAAACAATGCCAAAAAATACAGCGATGAGGTGCTATTCGTCACATGGTAGAAGACACCATCATTG
 CCAACAAAAACCAAACTTTGAAAGACAAGACCTCAAAGCAAAAAAATGGTCACTAGGCCAGTTGGATACC
 TTGATTGATGGTGGGGTTTACTTTACAGATACAAGTGGCAGTGGGCAAAGACGAGCAGATATCATGACCAA
 ACTAGACCAATGGATAGATGATCATGGAAGCACACCTGAGATTCCAGAACATCTCAAGATAACTTCCGGGA
 CACAATTTAGCGAAGTGCCCGTAGGTTATAAAGAAGTCAGCCACAAAACGTTTTGACCTACAAGTCAGAG
 ACCTACAGCTTTGGCCAATGCACCTGGTACGCCATAATCGTGTCAAAGAGCTAGGTTATCAAGTCGACAG
 GTACATGGGTAACGGTGGCGACTGGCAGCGCAAGCCAGGTTTTGTGACCACCCATAAACCTAAAGTGGGCT
 ATGTCGTCTCATTTCACCAGGCCAAGCAGGAGCAGATGCAACCTATGGTCACGTTGCTGTTGTAGAGCAA
 ATCAAAGAAGATGGTTCTATCTTAATTCAGAGTCAAATGTTATGGGACTAGGCACCATTTCTATCGGAC
 GTTCACAGCTGAGCAGGCTAGTTTGTGACCTATGTCTGATGGGGACAAACTCCCAAGACCATAA

SEQ ID NO: 106 amino acid sequence comprising GAS 137

MSDKHINLVIVTGMGAGKTVAIQSFEDLGYFTIDNMPPALVPKFLLELIEQTNENRRRVALVDDMRSLFFK
 EINSTLDSIESNPSIDFRILFLDATDGELVSRYKETRRSHPLAADGRVLDGIRLERELLSPLKSMSQHVVD
 TTKLTPRQLRKTISDQFSEGSNQASFRIEVMSFGFKYGLPLDADLVDFVDFLNPYPYQVELREKTGLDEDV
 FNYVMSPHESEVFYKHLNLIIVPILPAYQKEGKSVLTVAIIGCTGGQHRVAFVAFHCLAESLATDWSVNESHR
 DQNRKRVNRS

SEQ ID NO: 107 polynucleotide sequence encoding GAS 137

ATGTCAGACAAACACATTAATTTAGTTATTTGTGACAGGAAATGAGCGGCGCTGGAAAAACAGTTGCCATTCA
 GTCTTTTGGAGATCTAGGCTACTTTACCATGATAATATGCCCCAGCCTTGGTTCCAAAATTTTTAGAAT
 TAATTTGAACAAACCAATGAAAATCGTAGGGTGGCTTTGGTTGTGCGATATGAGAAGTCGTTTTGTTTTCAAG

SEQUENCE LISTING

GAAATTAATTCTACCTTAGATAGTATTGAAAGCAATCCTAGCATTGATTTTCGGATTCTTTTTTTGGATGC
AACGGATGGAGAAATTGGTGTACGCTATAAAGAAACCAGACGGAGCCACCCTTGGCTGCGGACGGTCGTG
TGCTTGATGGTATTCGATTGGAAAGAGAACTCCTATCTCCTTTGAAAAGCATGAGCCAACATGTGGTGGAT
ACAACAAAATTGACCCCTAGACAATTGCGTAAAACCATTTCAGACCAGTTTCTGAAGGGTCTAATCAAGC
CTCTTTCCGTATTGAAGTGATGAGCTTTGGGTTCAAATATGGTCTTCCCTTGGATGCGGATTTGGTTTTTG
ATGTGCGTTTTCTACCCAATCCTTATTATCAGGTAGAGCTTCGTGAAAAAACAGGACTAGATGAGGACGTT
TTAATTATGTGATGTCACCCAGAATCAGAGGTGTTTTACAAGCATTGTAAACCTTATTGTCCCTAT
CTTACCGGCTTACCAAAAAGAAGGGAAGTCTGTCTTGACGGTGGCTATTGGCTGCACAGGAGGCCAACACC
GCAGCGTTGCCCTTGGCCATTGCTTGGCAGAAAGTCTGGCAACAGATTGGTTCGGTTAATGAAAGCCATCGT
GATCAAAATCGTCTGTAAGGAAACGGTGAATCGTTCATGA

SEQ ID NO: 108 amino acid sequence comprising GAS 84

MIKKRTVAILAIASSFFLVACQATKSLKSGDAWGVYQKQKSIIVGFDNTFVPMGYKDESGRCKGFDIDLA
KEVFHQYGLKVNQAINWDMKEAELNNGKIDVIWNGYSITKERQDKVAFTDSYMRNEQIIVVKRSDIKTI
SDMKHKVLGAQSASSGYDSLRLTPKLLKDFIKNKDANQYETFTQAFIDLKSDRIDGILIDKVYANYLAK
QLENYRMIPTTFENEAFSVGLRKEDKTLQAKINRAFRVLYQNGKFOAISEKWFDDVATANIKS

SEQ ID NO: 109 polynucleotide sequence encoding GAS 84

ATGATTATAAAAAAAGAACCGTAGCAATTTAGCCATAGCTAGTAGCTTTTTCTTGGTAGCTTGTC AAGC
TACTAAAAGTCTTAAATCAGGAGATGCTTGGGGAGTTTACCAAAGCAAAAAGTATTACAGTTGGTTTTG
ACAATACGTTTGTTCCTATGGGCTATAAGGATGAAAGCGGCAGATGCAAAGGTTTTGATATTGATTTGGCT
AAAGAAGTTTTTACCAATATGGACTCAAGGTTAACTTTCAAGCTATTAATTGGGACATGAAAGAAGCAGA
ACTAAACAATGGTAAAATTGATGTAATCTGGAATGGTTATTCAATAACTAAGGAGCGTCAGGATAAGGTTG
CCTTTACTGATTCTTACATGAGAAATGAACAAATTATTGTTGTCAAAAAAGATCTGATATTTAAACAATA
TCAGATATGAAACATAAAGTGTTAGGAGCACAATCAGCTTCATCAGGTTATGACTCCTTGTTAAGAACTCC
TAAACTGCTGAAAGATTTTATTTAAAAATAAAGACGCTAATCAATATGAAACCTTTACACAAGCTTTTATTG
ATTTAAAATCAGATCGTATCGATGGAATATTGATTGACAAAGTATATGCCAATTACTATTTAGCAAAAAGAA
GGCAATTAGAGAATTATCGGATGATCCCAACGACCTTTGAAAATGAAGCATTTCGGTTGGACTTAGAAA
AGAAGACAAAACGTTGCAAGCAAAAATTAATCGTGCCTTCAGGGTGCCTTATCAAAAATGGCAAATTTCAAG
CTATTTCTGAGAAATGGTTTGGAGATGATGTTGCCACTGCCAATATTAATCTTAA

SEQ ID NO: 110 amino acid sequence comprising N-terminal leader sequence of GAS 84

MIKKRTVAILAIASSFFLVA

SEQ ID NO: 111 amino acid sequence comprising a fragment of GAS 84 where the N-terminal leader sequence is removed

CQATKSLKSGDAWGVYQKQKSIIVGFDNTFVPMGYKDESGRCKGFDIDLAKEVFHQYGLKVNQAINWDMK
EAELNNGKIDVIWNGYSITKERQDKVAFTDSYMRNEQIIVVKRSDIKTISDMKHKVLGAQSASSGYDSL
RTPKLLKDFIKNKDANQYETFTQAFIDLKSDRIDGILIDKVYANYLAKQLENYRMIPTTFENEAFSVG
LRKEDKTLQAKINRAFRVLYQNGKFOAISEKWFDDVATANIKS

SEQ ID NO: 112 amino acid sequence comprising GAS 384

MKTLAFDTSNKTLNLALDDETLADMTLNIQKKHSVSLMPAIDFLMTCIDLKPDLERIVVAKGPGSYTG
LRVAVATAKTLAYSLNIALVGISSLYALAASTCKQYPNTLVVPLIDARRONAYVGYRQKSVMPQAHASL
EVIIEQLVEEQLIFVGETAPFAEKIQKLLPQAILLPTLPSAYECGLLGQSLAPENVDAFVFPQYLKRV
EAEENWLKDNEIKDDSHYVKRI

SEQ ID NO: 113 polynucleotide sequence encoding GAS 384

ATGAAGACACTTGCAATTTGATACCTCAAATAAAACCTTGTCCTTACTTATGATGATGAGACACTTCT
AGCAGATATGACCCTAACATTAGAAAAACATAGTGTTAGCCTTATGCCTGCTATTGATTTTTTGGATGA
CTTGTACTGATCTTAAACCTCAAGATTTAGAAAAGAAATAGTGGTTGCAAAAGGCCCTGGATCTTACACAGGT
TTACGAGTGGCAGTTGCTACTGCAAAAACGTTAGCGTACAGTTTAAATATTGCATTGGTTCGGGATTTTCGAG
TCTATATGCTTTGGCTGCGTCTACTTGTAACAGTATCCAAATACCTTGGTGGTGCATTGATTGATGCTA
GAAGGCAAAATGCGTATGTAGGTTATTATCGGCAAGGAAAATCAGTGATGCCACAAGCCCATGCTTCACTA
GAAGTTATTATAGAACAATTAGTAGAAGAAGGACAGCTGATTTTTGTTGGGGAGACTGCTCCTTTTGTCTGA

SEQUENCE LISTING

GAAAATTCAAAGAAACTACCTCAGGCGATACTACTTCCAACCCCTCCTTCTGCCTTACGAATGTGGTCTTT
TGGGGCAAAGTTTGGCACCAGAAAATGTAGACGCCTTTGTCCCTCAATATCTCAAGAGAGTGAAGCTGAA
GAAACTGGCTCAAAGATAATGAGATAAAAGATGATAGTCACTACGTTAAGCGAATCTAA

SEQ ID NO: 114 amino acid sequence comprising GAS 202

MLKRLWLLIGPLLIAFVLVVTITFSFPTQLDHSIAQEKANAVAITDSSFKNGLIKRQALSDETCRFVPPFFG
SSEWSRMDSMHPSVLAERYKRSYRPFLLIGKRGSASLSHYGIQQITNEMQKKAIFVVSPOWFTAQGINPS
AVQMYLNSNTQVIEFLLKARTDKESQFAAKRLLLELNPVSKSNLLKKVSKGKLSRLDRAILKCOHQVALRE
ESLFSFLGKSTNYEKRILPRVKGLPKVFSYKQLNALATKRGQLATNNRFGIKNTFYRKRIAPKYNLYKNF
QVNYSYLASPEYNDFQLLLSEFAKRKTDVLFVITPVNKAWADYTLNODKYQAAVRKIKFQLKSQGFHRIA
DFSKDGGESYFMQDTIHLGWNGWLAFFDKKVQPFLETQKQVFNKMPYFYSKIWANRKLQ

SEQ ID NO: 115 polynucleotide sequence encoding GAS 202

ATGCTTAAGAGACTCTGGTTAATCTAGGTCCTCTTCTTATTGCCCTTGTGTTTAGTAGTGATTACTATTTT
TAGTTTTCCCTACACAACCTTGATCATTCCATAGCTCAGGAAAAGCAAATGCCGTTGCGATCACAGATAGTT
CTTTTAAAATGGTTTGATTAAGACAAGCTTTATCAGATGAGACTTGTCGTTTTGTGCCTTTTTTTGGT
CTAGCGAATGGAGTCGAATGGATAGTATGCACCTTCGGTGCCTGCAGAGCGCTACAAGCGGAGCTATAG
ACCATTTTTTAATTGGTAAGAGAGGATCAGCATCTTGTGCGCATTATTATGGTATACAACAAATACCAATG
AAATGCAAAAGAAAAAGCCATCTTTGTAGTATCTCCTCAATGGTTTACTGCTACAAGGGATTAATCCTAGT
GCGGTTCCAGATGTACTTGTCTAACACTCAAGTGATTGAATTTTTACTAAAAGCTAGAAGTATAAAGAATC
ACAGTTTGCAGCAAAGCGTTTGTGAGCTTAAACCTGGTGTGCTAAATCAAACCTTATTGAAAAAGTAA
GTAAGGGTAAGTCTCTTAGTCCGGTTAGACAGAGCTATTTGAAATGTCAACATCAAGTAGCATTGAGAGAA
GAGTCCCTTTTTAGTTTTTTAGGCAAATCTACTAACTATGAAAAAGAATTTTGCCTCGCGTTAAGGGATT
ACCTAAAGTATTTTCGTATAAACAATTGAATGCATTAGCAACTAAGAGAGGCCAATTAGCAACAACCAACA
ACCGTTTTGGGATTAATAATACATTTTATCGTAAACGAATAGCACCTAAATACAATCTTTATAAGAATTTT
CAAGTTAATTATAGTTACCTGGCGTACCAGATACCAATGATTTTTCAGCTTTTATTATCAGAATTTGCTAA
ACGAAAAACAGATGTACTCTTTGTTATAACTCCTGTATAAAGCTTGGGCGGATTATACCGGCTTAAATC
AAGATAAGTATCAAGCGGCAGTTTCGTAATAAATAAATCCAGTTAAAGTCACAAGGATTTTCATCGCATTGCT
GACTTCTCAAAGATGGTGGTGAGTCTACTTTATGCAAGATACCATCCATCTCGGTTGGAATGGCTGGTT
AGCTTTTGATAAGAAAGTGCAACCATTTCTAGAAACGAAGCAGCCAGTGCCTCAACTATAAATGAACCTT
ATTTTTATAGTAAAATTTGGGCAAATAGGAAAGACTTGCAATAG

SEQ ID NO: 116 amino acid sequence comprising GAS 057

MEKKQRFSLRKYKSGTFSVLIGSVFLVMTTVAADELSTMSEPTITNHAQQQAQHLTNTLSSAESKSQDT
SQITLKTNREKEQSQDLVSEPTTTELADTDAASMANTGSDATQKSASLPVNTDVHDWVKTKGAWDKGYKG
QGKVVAVIDTGDIPAHQSMRISDVSTAKVSKEDMLARQKAAGINYGSWINDKVVFAHNYVENSJNIKENQ
FEDFDEDWENFEFDAEAEPKAIKHKIYRPQSTQAPKETVIKTEETDGSHDIDWTQTDDDTKYESHGMHVT
GIVAGNSKEAAATGERFLGIAPEAQVMFMRVVFANDIMGSAESLFKAIEDAVALGADVINLSLGTANGAQL
SGSKPLMEAI EKAKKAGVSVVVAAGNERVYGS DHDDPLATNPDYGLVGS PSTGRTPTSVAAINSKWWIQRL
MTVKELENRADLNHGKAIYSESVDFKDIKDSLGYDKSHQFAYVKESTDAGYNAQDVKGKIALIERDPNKTY
DEMIALAKKHGALGVLI FNNKPGQSNRSMRLTANGMGI P S A F I S H E F G K A M S Q L N G N G T G S L E F D S V V S K A
P S Q K G N E M N H F S N W G L T S D G Y L K P D I T A P G G D I Y S T Y N D N H Y G S Q T G T S M A S P Q I A G A S L L V K Q Y L E K T Q P
N L P K E K I A D I V K N L L S N A Q I H V N P E T K T T S P R Q Q G A G L L N I D G A V T S G L Y V T G K D N Y G S I S L G N I T D T M
T F D V T V H N L S N K D K T L R Y D T E L L T D H V D P Q K G R F L T S H S L K T Y Q G G E V T V P A N G K V T V R V T M D V S Q F T K E
L T K Q M P N G Y Y L E G F V R F R D S Q D D Q L N R V N I P F V G F K G Q F E N L A V A E E S I Y R L K S Q G K T G F Y F D E S G P K D D I
Y V G K H F T G L V T L G S E T N V S T K T I S D N G L H T L G T F K N A D G K F I L E K N A Q G N P V L A I S P N G D N N Q D F A A F K G V
F L R K Y Q G L K A S V Y H A S D K E H K N P L W V S P E S F K G D K N F N S D I R F A K S T L L G T A F S G K S L T G A E L P D G H Y H Y
V V S Y P D V V G A K R Q E M T F D M I L D R Q K P V L S Q A T F D P E T N R F K P E P L K D R G L A G V R K D S V F Y L E R K D N K P Y T
V T I N D S Y K Y V S V E D N K T F V E R Q A D G S F I L P L D K A K L G D F Y M V E D F A G N V A I A K L G D H L P Q T L G K T P I K L K
L T D G N Y Q T K E T L K D N L E M T Q S D T G L V T N Q A Q L A V V H R N Q P O S Q L T K M N Q D F F I S P N E D G N K D F V A F K G L K N
N V N D L T V N V Y A K D D H Q K Q T P I W S S Q A G A S V S A I E S T A W Y G I T A R G S K V M P G D Y Q Y V V T Y R D E H G K E H Q K Q
Y T I S V N D K K P M I T Q G R F D T I N G V D H F T P D K T K A L D S S G I V R E E V F Y L A K N G R K F D V T E G K D G I T V S D N K V
Y I P K N P D G S Y T I S K R D G V T L S D Y Y L V E D R A G N V S F A T L R D L K A V G K D K A V V N F G L D L P V P E D K Q I V N F T Y
L V R D A D G K P I E N L E Y Y N N S G N S L I L P Y G K Y T V E L L T Y D T N A A K L E S D K I V S F T L S A D N N F Q Q V T F K I T M L A
T S Q I T A H F D H L L P E G S R V S L K T A Q D Q L I P L E Q S L Y V P K A Y G K T V Q E G T Y E V V V S L P K G Y R I E G N T K V N T L P

SEQUENCE LISTING

NEVHEL SLRLVKVG D ASDSTGDH KVM SKNNSQAL TASAT PTKSTTSATAKALPSTGEKMGLKLRIVGLVLL
GLTCVFSRKKSTKD

SEQ ID NO: 117 polynucleotide sequence encoding GAS 057

GTGGAGAAAAGCAACGTTTTTCCTTAGAAAATACAAATCAGGAACGTTTTTCGGTCTTAATAGGAAGCGT
TTTCTTGGTGATGACAACAACAGTAGCAGCAGATGAGCTAAGCACAATGAGCGAACCAACAATCACGAATC
ACGCTCAACAACAACGCGCAACATCTACCAATACAGAGTTGAGCTCAGCTGAATCAAATCTCAAGACACA
TCACAAATCACTCTCAAGACAAATCGTGAAAAGAGCAATCACAAGATCTAGTCTCTGAGCCAACCACAAC
TGAGCTAGCTGCACAGATGCAGCATCAATGGCTAATACAGGTTCTGATGCGACTCAAAAAGCGTTCTT
TACCGCCAGTCAATACAGATGTTTACGATTGGGTA AAAACCAAAGGAGCTTGGGACAAGGGATACAAAGGA
CAAGGCAAGGTTGTGCGAGTTATTGACACAGGGATCGATCCGGCCCCATCAAAGCATGCGCATCAGTGATGT
ATCAACTGCTAAAGTAAAATCAAAGAAGACATGCTAGCACGCCAAAAGCCGCGGTATTAATTATGGGA
GTTGGATAAATGATAAAGTTGTTTTTGCACATAATTATGTGAAAATAGCGATAATATCAAAGAAAATCAA
TTCGAGGATTTTGATGAGGACTGGGAAAACTTTGAGTTTGATGCAGAGGCAGAGCCAAAAGCCATCAAAA
ACACAAGATCTATCGTCCCAATCAACCCAGGCACCGAAAAGAACTGTTATCAAACAGAAAGAAACAGATG
GTTACATGATATTGACTGGACAAAACAGACGATGACACCAATACGAGTCACACGGTATGCATGTGACA
GGTATTGTAGCCGGTAATAGCAAAGAAGCCGCTACTGGGAAACGCTTTT TAGGAATTGCACCAGAGGC
CCAAGTCATGTTTATGCGTGTTTTTTGCCAACGACATCATGGGATCAGCTGAATCACTTTTATCAAAGCTA
TCGAAGATGCCGTGGCTTTAGGAGCAGATGTGATCAACCTGAGTCTTGGAACCGCTAATGGGGCAGAGCTT
AGTGGCAGCAAGCCTCTAATGGAAGCAATTGAAAAGCTAAAAAGCCGGTGTATCAGTTGTTGTAGCAGC
AGGAAATGAGCGCTCTATGGATCTGACCATGATGATCCATTGGCGACAAATCCAGACTATGGTTTGGTTCG
GTTCTCCCTCAACAGGTCGAACACCAACATCAGTGGCAGCTATAACAGTAAGTGGGTGATTCAACGTCTA
ATGACGGTCAAAGAATTGAAAACCGTGCCGATTTAAACCATGGTAAAGCCATCTATT CAGAGTCTGTGCA
CTTTAAAGACATAAAAAGTAGCCTAGGTTATGATAAATCGCATCAATTTGCTTATGTCAAAGAGTCAACTG
ATGCGGGTTATAACGCACAAGACGTTAAAGGTA AAAATGCTTTAATTGAACGTGATCCCAATAAAACCTAT
GACGAAATGATTGCTTTGGCTAAGAAAACATGGAGCTCTGGGAGTACTTATTTTTAATAACAAGCCTGGTCA
ATCAAACCGCTCAATGCGTCTAACAGCTAATGGGATGGGGATACCATCTGCTTTCATATCGCAGCAATTTG
GTAAGGCCATGTCCAATTAATGGCAATGGTACAGGAAGTTTAGAGTTTGACAGTGTGGTCTCAAAAAGCA
CCGAGTCAAAAAGGCAATGAAATGAATCATTTTTCAAATTTGGGGCTAAC TCTGATGGCTATTTAAAACC
TGACATTACTGCACCAGGTGGCGATATCTATTCTACCTATAACGATAACCACTATGGTAGCCAAACAGGAA
CAAGTATGGCCTCTCTCAGATTGCTGGCGCCAGCCTTTTGGTCAAACAATACCTAGAAAAGACTCAGCCA
AATTTGCCAAAAGAAAATTTGCTGATATCGTTAAGAACC TATTGATGAGCAATGCTCAAATTCATGTTAA
TCCAGAGACAAAACACCTCACC GCGTCAGCAAGGGGCAGGATTACTTAATATTGACGGAGCTGTCA
CTAGCGGCCTTTATGTGACAGGAAAAGACAATAAGGAGTATATCATTAGGCAACATCAGAGATACGATG
ACGTTTGATGTGACTGTTTCAACAACCTAAGCAATAAAGACA AAAACATTACGTTATGACACAGAAATGCTAAC
AGATCATGTAGACCCACAAAAGGGCCGCTTCACTTTGACTTCTCACTCCTTAAAACGTTACCAAGGAGAG
AAGTTACAGTCCAGCCAATGGAAAAGTACTGTAAGGGTTACCATGGATGTCTCACAGTTCACAAAAGAG
CTAACAAAACAGATGCCAAATGGTTACTATCTAGAAGGTTTGTCCGCTTTAGAGATAGTCAAGATGACCA
ACTAAATAGAGTAAACATTTCTTTTGGTTTAAAGGGCAATTTGAAAAC TTAGCAGTTGCAGAAGAGT
CCATTTACAGATTA AAAATCTCAAGGCAAAACTGGTTTTACTTTTGATGAATCAGGTCCAAAAGACGATATC
TATGTCGGTAAACACTTTACAGGACTTGTCACTCTTGGTT CAGAGACCAATGTGTCAACCAAACGATTTT
TGACAATGGTCTACACACACTTGGCACCTTTAAAATGCAGATGGCAAATTTATCTTAGAAAAAATGCC
AAGGAAACCCTGTCTTAGCCATTTCTCCAAATGGTGACAACAACCAAGATTTG CAGCCTTCAAAGGTGTT
TCTTTGAGAAAATATCAAGGCTTAAAAGCAAGTGCTACCATGCTAGTGACA AAGGAACACAAAATCCACT
GTGGGTCAGCCCAGAAAGCTTTAAAGGAGATAAAAAC TTTAATAGTGACATTAGATTTGCAAATCAACGA
CCCTGTTAGGCACAGCATTCTTGAAAATCGTTAACAGGAGCTGAATTACCAGATGGGCATTATCATTAT
GTGGTGTCTTATTACCCAGATGTGGTTCGGTGCCAAACGTCAAGAAATGACATTTGACATGATTTTAGACCG
ACAAAACCGGTACTATCACAAGCAACATTTGATCCTGAAACAAACCGATTC AAACCAGAACCCCTAAAAG
ACCGTGGATTAGCTGGTGTTCGCAAAGACAGTGTCTTTTATCTAGAAAAGAAAAGACAACAAGCCTTATACA
GTTACGATAAAACGATAGCTACAAATATGCTCAGTAGAAGACAATAAAACATTTGTGGAGCGACAAGCTGA
TGGCAGCTTTATCTTGGCGCTTGATAAAGCAAATTTAGGGGATTTCTATTACATGGTCCGAGGATTTTGCAG
GGAACGTGGCCATCGCTAAGTTAGGAGATCACTTACCACAAAACATTAGGTTAAAACACCAATTAACCTTAAG
CTTACAGACGGTAATTATCAGACCAAAGAAACGCTTAAAAGATAATCTTGA AATGACACAGTCTGACACAGG
TCTAGTCACAAATCAAGCCCAGCTAGCAGTGGTGCACCGCAATCAGCCGCAAAGCCAGCTAACAAAGATGA
ATCAGGATTTCTTTATCTCACC AAACGAAGATGGGAATAAAGACTTTGTGGCCTTTAAAGGCTTGAAAAT
AACGTGTATAATGACTTAACGGTTAACGTATACGCTAAAGATGACCACCAA AACAACCCCTATCTGGTC

SEQUENCE LISTING

TAGTCAAGCAGGCGCTAGTGTATCCGCTATTGAAAGTACAGCCTGGTATGGCATAACAGCCCGAGGAAGCA
 AGGTGATGCCAGGTGATTATCAGTATGTTGTGACCTATCGTGACGAACATGGTAAAGAACATCAAAAAGCAG
 TACACCATATCTGTGAATGACAAAAACCAATGATCACTCAGGGACGTTTGTATACCATTAATGGCGTTGA
 CCACTTTACTCCTGACAAGACAAAAGCCCTTGACTCATCAGGCATGTCCGCGAAGAAGTCTTTTACTTGG
 CCAAGAAAAATGGCCGTAAATTTGATGTGACAGAAGGTAAAGATGGTATCACAGTTAGTGACAATAAGGTG
 TATATCCCTAAAAATCCAGATGGTTCTTACACCATTTCAAAAAGAGATGGTGTCCACACTGTCA GATTATTA
 CTACCTTGTCGAAGATAGAGCTGGTAATGTGTCTTTTGTCTACCTTGCCTGACCTAAAAGCGGTCCGAAAAG
 ACAAGCAGTAGTCAATTTTGGATTAGACTTACCGGTCCCTGAAGACAAACAAATAGTGAACCTTACCTTAC
 CTTGTGCGGGATGCAGATGGTAAACCGATTGAAAACCTAGAGTATTATAATAACTCAGGTAACAGCTTTAT
 CTTGCCATACGGCAATACACGGTCAATTTGTTGACCTATGACACCAATGCAGCCAAACTAGAGTCAGATA
 AAATCGTTTCCTTTACCTTGTGACCTGATAACAACCTTCCAACAAGTTACCTTTAAGATAACGATGTTAGCA
 ACTTCTCAAATAACTGCCCACTTTGATCATCTTTTCCAGAAGGCAGTCGCGTTAGCCTTAAAACAGCTCA
 AGATCAGCTAATCCCGCTTGAACAGTCTTGTATGTGCTTAAAGCTTATGGCAAACCGTTCAAGAAGGCA
 CTTACGAAGTTGTTGTGACCTGCCTAAAAGGCTACCGTATCGAAGGCAACACAAAGGTGAATACCTACCA
 AATGAAGTGCACGAATATCATTACGCTTGTCAAAGTAGGAGATGCCTCAGATTCAACTGGT GATCATAA
 GGTATGTCAAATAAATTCACAGGCTTTGACAGCCTTGCACACCAACCAAGTCAACGACCTCAGCAA
 CAGCAAAAGCCCTACCATCAACGGGTGAAAAAATGGGTCCTCAAGTTGCGCATAGTAGGTCTTGTGTTACTC
GGACTTACTTGCCTCTTTAGCCGAAAAAATCAACCAAGATTGA

SEQ ID NO: 118 amino acid sequence comprising N-terminal leader sequence of GAS 57
 MEKKQRFSLRKYKSGTFSVLIGSVFLVMTTVA

SEQ ID NO: 119 amino acid sequence comprising a fragment of GAS 57 where the N-terminal
 leader sequence is removed

ADELSTMSEPTITNHAQQQAQHLTNTLSSAESKSQDTSQITLKTNREKEQSQDLVSEPTTTELADTDAAS
 MANTGSDATQKSASLPPVNTDVHDVWVKTKGAWDKGYKQGVVAVIDTGIDPAHQSMRISDVSTAKVKSKE
 DMLARQKAAGINYSWINDKVVFAHNYVENSNDNIKENQFEDFEDWENFEFDAEAEPKAIKKHKIYRQST
 QAPKETVIKTEETDGSHDIDWTQTDDETKYESHGMHTGIVAGNSKEAAATGERFLGIAPEAQVMFMRVFA
 NDIMGSAESLFIKAIEDAVALGADVNLISLGTANGAQLSGSKPLMEAIKAKKAGVSVVVAAGNERVYVSD
 HDDPLATNPDYGLVSPSTGRTPTSVAAINSKWVIQRLMTVKELENRADLNHGKAIYSESVDKDIKDSL
 YDKSHQFAYVKESTDAGYNAQDVKGKIALIERDPNKTYDEMIALAKKHGALGVLI FNNKPGQSNRSMRLTA
 NGMGI PSAFI SHEFGKAMSQNLNGNGTGSLEFDSVVS KAPSQKGNEMNHF SNWGLTSDGYLKPDI TAPGGDI
 YSTYNDNHYSQTGTSMAS PQIAGASLLVKQYLEKTQPNLPKEKIADIVKNLLMSNAQIHVNPETKTTTSP
 RQQGAGLLNIDGAVTSGLYVTGKDNYSISLGNITD TMTFDVTVHNL SNKDKTLRYDTELLTDHVDPQKGR
 FTLSHSLKTYQGGVTV PANGKVTVRVTMDVSQFTKELTKOMPNGYYLEGFVFRFRDSQDDQLNRVNI PFV
 GFKGQFENLAVAEESIYRLKSQKTFYFDES GPKDDIYVGKHF TGLVTLGSETNVSTKTI SDNGLHTLGT
 FKNADGKFI LEKNAQGNPVLAI SPNGDNNQDFAAFKGVFLRKYQGLKASVYHSDKEHKNPLWVSPESFKG
 DKNFNSDIRFAKSTLLGTA FSGKSLTGAELPDGHYHYVVSYPDVVGAKRQEMTFDMILDRQKPVLSQAT
 FDPETNRFKPEPLKDRGLAGVRKDSV FYLERKDNKPYTVTINDSYKYVSVEDNKTFVERQADGSFILPLDK
 AKLGDFFYIMVEDFAGNVAIAKLG DHPQTLGKTP I KLKLTGDN YQTKETLKNLEMTQSDTGLVTNQAQLA
 VVHRNQPSQLTKMNQDFFI SPNE DGNKDFVAFKGLKNNVYNDLTVNVYAKDDHQKQTP IWSSQAGASVSA
 IESTAWYGITARGSKVM PGDYQYVVTYRDEHGKEHQKQYTI SVNDKKPMITQGRFDTINGVDHFT PDKTKA
 LDSSGIVREEV FYLAKKNGRKF DVTEGKDGITVSDNKVYI PKNPDGSYTI SKRDGVTLS DYYYYLVEDRAGN
 VSFATLRDLKAVGKDKAVVNFGLDLPVPEDKQIVNFYTLVRDADGKPIENLEYNNSGNLILPYGKYTVE
 LLTYDTNAAKLES DKIVSFTLSADNNFQQVTFKIMLATSQITAHFDHLL PEGSRVSLKTAQDQLI PLEQS
 LYVPKAYGKT VQEGTYEVVVS LPKGYRIEGNTKVNTLPNEVHEL SLRLVKVGDASDSTGDHKVMSKNNSQA
 LTASATPTKSTTSATAKALPSTGEKMGLKLRIVGLVLLGLTCVFSRKKSTKD

SEQ ID NO: 120 amino acid sequence comprising C-terminal hydrophobic region
 LPSTGEKMGLKLRIVGLVLLGLTCVFSRKKSTKD

SEQ ID NO: 121 amino acid sequence comprising a fragment of GAS 57 where the C-terminal
 hydrophobic region is removed

MEKKQRFSLRKYKSGTFSVLIGSVFLVMTTVADELSTMSEPTITNHAQQQAQHLTNTLSSAESKSQD
 SQITLKTNREKEQSQDLVSEPTTTELADTDAAS MANTGSDATQKSASLPPVNTDVHDVWVKTKGAWDKGYK
 QGVVAVIDTGIDPAHQSMRISDVSTAKVKS KEDMLARQKAAGINYSWINDKVVFAHNYVENSNDNIKENQ

SEQUENCE LISTING

FEDFDEDWENFEFDAEAEPKAIKKHKIYRPOSTQAPKETVIKTEETDGS SHDIDWTQTD DDTKYESHGMHVT
 GIVAGNSKEAAATGERFLGLAPEAQVMFMRVVFANDIMGSAESLFIKAIEDAVALGADV INLSLGTANGAQL
 SCSKPLMEAI EKAKKAGVSVVVAAGNERVYGS DHDDPLATNP DYGLV GSPSTGRTP TSVAAINS KWVIQRL
 MTVKELENRADLNHGKAIYSESVDPKDIKDSLGYDKSHQFAYVKESTDAGYNAQDVKGKIALIERDPNKTY
 DEMIALAKKHGALGVLIFNNKPGQSNRSMRLTANGMGI PSAFISHEFGKAMSQNLNGNGTGSLEFDSVVS KA
 PSQGNEMNHFSNWGLTSDGYLKPDI TAPGGDIYSTYNDNHYGSQTGTSMAS PQIAGA SLLVKQYLEKTQP
 NLPKEKIADIVKNLLMSNAQIHVNPEKTTTSPRQQAGLLNIDGAVTSGLYVTGKDN YGSI SLGNITDTM
 TFDVTVHNL SNKDKTLRYDTELLTDHVDPQKGRFTLTSHSLKTYQGGEVTV PANGKVTVRVTMDVSOFTKE
 LTKQMPNGYYLEGFVFRFRDSQDDQLNRVNI PFVGFKGQFENLAVAEESIYRLKSQGKTGFYFDESGPKDDI
 YVGKHF TGLVTLGSETNVSTKTI SDNGLHTLGT FKNADGKFI LEKNAQGNPVLAI SPNGDNNQDFAAFKGV
 FLRKYQGLKASVYHSDKEHKNPLWVSPESFKGDKNFNSDIRFAKSTLLGTAFSGKSLTGAELPDGHYHY
 VVSYPDVVGAQRQEMTFDMILDRQKPVLSQATFDPETNRFKPEPLKDRGLAGVRKDS VFYLERKDNKPYT
 VTINDSYKYVSVEDNKTFVERQADGSFILPLDKAKLGDFFYMVEDFAGNVAIAKLG DHLPQTLGKTP IKLK
 L TDGNYQTKETLKNLEMTQS DTGLVTNQAQLAVVHRNQPSQLTKMNQDFFISPNE DGNKDFVAFKGLKN
 NVYNLTVNVYAKDDHQKQTP IWSSQAGASVSAIESTAWYGITARGSKVMPGDYQYVV TYRDEHGKEHQKQ
 YTISVNDKKPMITQGRFDTINGVDHFTPDKTKALDSSGIVREEVFYLA KNGRKF DVTEGKDGITVSDNKV
 YIPKNPDG SYTISKRDGVTLS DYYYLVEDRAGNVSFATLRDLKAVGKDKAVVNFGLDL PVPEDKQIVNFTY
 LVRDADGKPIENLEYNNNSGNLILPYGKYTVELLTYDTNAAKLES DKIVSF TLSADNNFQQVTFKITMLA
 TSQITAHFDHLLPEGSRVSLKTAQDQLI PLEQSLYVPKAYGKTVOEGTYEVV VSLPKGYRIEGNTKVNTLP
 NEVHEL SLRLVKVG DADSDSTGDHKVMSKNNSQAL TASATPTKSTTSATAKA

SEQ ID NO: 122 amino acid sequence comprising a fragment of GAS 57 where both the N-terminal leader sequence and the C-terminal hydrophobic region are removed

ADELSTMSEPTITNHAQQQAHLTNTLSSAESKSQDTSQITLKTNREKEQSQDLVSEPTTTELADTDAAS
 MANTGSDATQKSASLPPVNTDVHDWVKTGAWDKGYKQGKVVAVIDTGIDPAHQSMRI SDVSTAKVKSKE
 DMLARQKAAGINYSWINDKVVFAHNYVENSNDNIKENQFEDFDEDWENFEFDAEAEPKAIKKHKIYRPOST
 QAPKETVIKTEETDGS SHDIDWTQTD DDTKYESHGMHVTGIVAGNSKEAAATGERFLGLAPEAQVMFMRVFA
 NDIMGSAESLFIKAIEDAVALGADV INLSLGTANGAQLSGSKPLMEAI EKAKKAGVSVVVAAGNERVYGS
 HDDPLATNP DYGLV GSPSTGRTP TSVAAINS KWVIQRLMTVKELENRADLNHGKAIYSESVDPKDIKDSL
 YDKSHQFAYVKESTDAGYNAQDVKGKIALIERDPNKTYDEMIALAKKHGALGVLIFNNKPGQSNRSMRLTA
 NGMGI PSAFISHEFGKAMSQNLNGNGTGSLEFDSVVS KAPSQGNEMNHFSNWGLTSDGYLKPDI TAPGGDI
 YSTYNDNHYGSQTGTSMAS PQIAGASLLVKQYLEKTQPNLPKEKIADIVKNLLMSNAQIHVNPEKTTTSP
 RQQAGLLNIDGAVTSGLYVTGKDN YGSI SLGNITDTMTFDVTVHNL SNKDKTLRYDTELLTDHVDPQKGR
 FTLTSHSLKTYQGGEVTV PANGKVTVRVTMDVSOFTKELTKQMPNGYYLEGFVFRFRDSQDDQLNRVNI PFV
 GFKGQFENLAVAEESIYRLKSQGKTGFYFDES GPKDDIYVGKHF TGLVTLGSETNVSTKTI SDNGLHTLGT
 FKNADGKFI LEKNAQGNPVLAI SPNGDNNQDFAAFKGVFLRKYQGLKASVYHSDKEHKNPLWVSPESFKG
 DKNFNSDIRFAKSTLLGTAFSGKSLTGAELPDGHYHYVVSYPDVVGAQRQEMTFDMI LDRQKPVLSQAT
 FDPETNRFKPEPLKDRGLAGVRKDSVFYLERKDNKPYTVTINDSYKYVSVEDNKTFVERQADGSFILPLDK
 AKLGDFFYMVEDFAGNVAIAKLG DHLPQTLGKTP IKLK L TDGNYQTKETLKNLEMTQS DTGLVTNQAQLA
 VVHRNQPSQLTKMNQDFFISPNE DGNKDFVAFKGLKNNVYNLTVNVYAKDDHQKQTP IWSSQAGASVSA
 IESTAWYGITARGSKVMPGDYQYVV TYRDEHGKEHQKQYTI SVNDKKPMITQGRFDTINGVDHFTPDKTKA
 LDSSGIVREEVFYLA KNGRKF DVTEGKDGITVSDNKVYI PKNPDG SYTISKRDGVTLS DYYYLVEDRAGN
 VSFATLRDLKAVGKDKAVVNFGLDL PVPEDKQIVNFTY LVRDADGKPIENLEYNNNSGNLILPYGKYTV
 LLTYDTNAAKLES DKIVSF TLSADNNFQQVTFKITMLATSQITAHFDHLLPEGSRVSLKTAQDQLI PLEQS
 LYVPKAYGKTVOEGTYEVV VSLPKGYRIEGNTKVNTLPNEVHEL SLRLVKVG DADSDSTGDHKVMSKNNSQA
 LTASATPTKSTTSATAKA

SEQ ID NO: 123 amino acid sequence of a GAS M protein

MAKNNTNRHYSRLKLTGTASVAVALTVLGAGFANQTEVKANGDGNPREVIEDLAANNPAIQNIRLRYENK
 DLKARLENAMVAGRDFKRAEELKAKQALEDRKDLETKLKELQQDYDLAKESTSWDRQRLEKELEEKKE
 ALELAIDQASRDYHRATALEKELEEKKALELAIDQASQDYNRANVLEKELETTITREQETINRNLGNKLE
 LDQLSSEKEQLTIEKALEEKQISDASRQGLRRDLASREAKKQVEKDLANLTAELDKVKEKDKQISDASR
 QGLRRDLASREAKKQVEKDLANLTAELDKVKEEKQISDASRQGLRRDLASREAKKQVEKALEEANSKLA
 ALEKLNKELEESKLTETEKAELQAKLEAEAKALKEQLAKQAEELAKLRAGKASDSQTPDTKPGNKAVPGK
 GQAPQAGTKPNQNKAPMKETKRQLPSTGETANPFFTAALTVMATAGVAAVVKKREEN

SEQUENCE LISTING

SEQ ID NO: 124 amino acid sequence of GAS SfbI

MSFDGFFLHHLTNELKENLLYGRIQKVNQPFERELVLTIRNHRKNYKLLLSAHPVFGFRVQITQADFQNPQV
 PNTFTMIMRKYLQGAVIDEQLQIDNDRIIEIKVSNKNEIGDAIQATLIIEIMGKHSNIIIVDRAENKIIIES
 IKHVGFSONSYRTILPGSTYIEPPKTAAVNPFITDVLPEILQIQELTVKSLQQHFQGLGRDTAKELAE
 LTTDKLKRFRFFARPTQANLTTASFAFVLFSDSHATFETLSMDLDFYQDKAERDRINQQASDLIHRVQT
 ELDKNRNKLKQEAELLATENAELFRQKCELLTYYLSLVPNNQDSVILDNYTGEKIEIALDKALTPNQNA
 QRYFKKYQKLKEAVKHLGLIADTKQSITYFESVDYNSQASIDDIEDI REELYQAGFLKSRQRDKRHKRK
 KPEQYLASDGTIILMVGRNMLQNEELTFKMAKKGELWFHAKDIPGSHV I I KDNLDF SDEVKTDAAELAAYY
 SKARLSNLVQVDMIEAKKLHKPSGAKPGFVTTYTGQKTLRVTPDQAKILSMKLS

SEQ ID NO: 125 amino acid sequence of a GAS Shp protein

MTKVVIKQLLQVIVVFMISLSTMTNLVYADKQIYGCIIQRNYRHPISGQIEDSGGEHSFDIGQGMVEGTV
 YSDAMLEVSDAGKIVLTFRMSLADYSGNYQFWIQPGGTGSFQAVDYNITQKGTDTNGTTLDAISLPTVNS
 IIRGSMFVEPMGREVVFLSASELIQKYSNMLAQLVTFEDNSQNQEVKDSQKPVDTKLGESQDESHTGAM
 ITQNKPKANSNNKSLSDKKILPSKMGLTTSLELKKEDKFRSKDLSIMIYYFPFFFLMLGGFAVWVWKKR
 KKNDKTM

SEQ ID NO: 126 amino acids 10 to 30 of GAS protein SagA

FSIATGSGNSQGGSGSYTPGKC

SEQ ID NO: 127 polynucleotide sequence comprising fusion construct 117-40a-RR

ATGGCCTTTAAACACAAGCCAGAGTGTCTAGTGCACAAGTTTATAGCAATGAAGGGTATCACCAGCATTGAC
 TGATGAAAAATCACACCTGCAATATAGTAAAGACAACGCACAACCTCAATTGAGAAAATATCCTTGACGGCT
 ACCAAAATGACCTAGGGAGACACTACTCTAGCTATTACTTACTACAACCTAAGAACCGTTATGGGACTATCA
 AGTGAGCAAGACATTGAAAAACTATGAAGAGCTTAAAGACAAGTTACATGATATGTACAATCATTATGc
 tagcggtagcggatccATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAA
 CGAAGGCGAGTAATACTCACGACGATAGTTTACAAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATT
 GATGCAGTTGAAAAACTCTCAGTCAACAAAAAGCAGAATGACAGAGCTTGCTACCCTCTGACAAAAAC
 TACTGCTGAAATCAACCCTTAAAAGAGCAGCAAGTAAATGAACAAAAAGCTTTAACCTCTGCACAAGAAA
 TTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAGAGAGTTA
 ACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGACTGCATTGTGAGAAC
 AAAAGCTAGCATTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAAACGCTCTGAACAAA
 ATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGAT
 AATACAAAAGCATTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAA
 AAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAAGCTGCTCTAGCAGAAAAGAGGCAGAACTTAGTCGTC
 TTAATCCTCAGCTCCGCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCAGGATTTCA
 CCTCTTGAAGAACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAA
 AGAGCATGCAGATCAAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGATATTCCAG
 CAGATCGTAATCGCTTTGTTGATCCCATAATTTGACACCAGAGTGCAAAATGAGCTAGCGCAGTTTGA
 GCTCACATGATTAATAGTGTAcGtCgtCAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGA
 ATTTGCAAGATTACTTAGTACCAGCTATAAGAAAACCTATGGTAATACAAGACCATCATTTGTCTACGGAC
 AGCCAGGGGTATCAGGGCATTATGGTGTGGGCTCATGATAAACTATTTATTGAAGACTCTGCCGGAGCG
 TCAGGGCTCATTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACTGTGAA
 TGGTATTAAACGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACA GATCATTTACACGGAAATACAT
 ACGGCCATGCTATTAACTTTTTACGTGTAGATAAACATAACCCTAATGC GCCTGTTTACCTTGGATTTTCA
 ACCAGCAATGTAGGACTTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACG
 CTTTAATAAGACCCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACCTGTATCTG
 ATACTATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTCATCAAGAAGCT
 GATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGA
 CAGCTTAAATCTCCAAGTGAGACAATTAATGATACTAAAGGTTCTTTGAGAACAGAAATTACTAGCAGCTA
 AAGCAAAACAAGCACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCA
 CTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACTGGTGGCTAAAAAAGCTCA
 TTTGCAATATCTAAGGGACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATA
 CTAAGCAAGATTGGCTAAAACCTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCT
 AAACAAAGCAGTTAGAACTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAAACCTTAGCTAA
 CGAAAAGGAATATCGCCACTTAGACGAAGATATAGCTACTGTGCTGATTTGCAAGTAGCTCCACCTCTTA

SEQUENCE LISTING

CGGGCGTAAAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAGAAACG
 AAACAACCTATTAGAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGG
 CCAAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCAT
 CTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTCTGATGTTGATGAAAGTACTCAA
 cGtgcggccgactcgagCACACCACCACCACCAC

SEQ ID NO: 128 amino acid sequence comprising fusion construct 117-40a-RR

M A F N T S Q S V S A Q V Y S N E G Y H Q H L T D E K S H L Q Y S K D N
 A Q L Q L R N I L D G Y Q N D L G R H Y S S Y Y Y N L R T V M G L S S
 E Q D I E K H Y E E L K N K L H D M Y N H **Y A S G G G S** M S V G V S H Q
 V K A D D R A S G E T K A S N T H D D S L P K P E T I Q E A K A T I D A
 V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H L K E Q Q D N E
 Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E H Q R E L T A T
 E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E T T R A Q D L V
 E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q T A N D N T K A
 L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A A Q K A A L A E
 K E A E L S R L K S S A P S T Q D S I V G N N T M K A P Q G Y P L E E L
 K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K A S P G N Q L N
 Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A Q F A A H M I N S
 V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y K K T H G N T R P
 S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A G A S G L I R N D
 D N M Y E N I G A F N D V H T V N G I K R G I Y D S I K Y M L F T D H L
 H G N T Y G H A I N F L R V D K H N P N A P V Y L G F S T S N V G S L N
 E H F V M F P E S N I A N H Q R F N K T P I K A V G S T K D Y A Q R V G
 T V S D T I A A I K G K V S S L E N R L S A I H Q E A D I M A A Q A K V
 S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T K G S L R T E L L
 A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L H Q T E A L A E Q
 A A A R V T A L V A K K A H L Q Y L R D F K L N P N R L Q V I R E R I D
 N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q S S L E A T I A T
 T E H Q L T L L K T L A N E K E Y R H L D E D I A T V P D L Q V A P P L
 T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L L E A S A R L A A
 E N T S L V A E A L V G Q T S E M V A S N A I V S K I T S S I T Q P S S
 K T S Y G S G S S T T S N L I S D V D E S T Q R A A A L E H H H H H

SEQ ID NO: 129 amino acid sequence comprising a linker in the 117-40a-RR construct
 YASGGGS

SEQ ID NO: 130 polynucleotide sequence comprising 40a-RR-117 fusion construct

ATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATAC
 TCACGACGATAGTTTACCAAAACAGAAACAATTCAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAAA
 CTCTCAGTCAACAAAAGCAGAAGTACAGAGCTTGCTACCGCTCTGCACAAAACCTACTGCTGAAATCAAC
 CACTTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCT
 TGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAAATCAAAGAGAGTTAACAGCTACTGAAACAG
 AGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTCAGAACAAAAGCTAGCATTTCA
 GCAGAACTACTCGAGCTCAAGATTTAGTGGAAACAGTCAAACCGTCTGAACAAAATATTGCTAAGCTCAA
 TGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTAA
 GCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAAGTTAAAAGCAATTGACTGAA
 GAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAGAGGCAGAAGCTTAGTGTCTTAAATCCTCAGCTCC
 GTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCAGGCTATCCTCTTGAAGAACTTA
 AAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATATTACAAAAGAGCATGCAGACTCA
 ATTATTGCCAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGATATTCCAGCAGATCGTAATCGCTT
 TGTTGATCCCATAATTTGACACCAGAAAGTCAAATGAGCTAGCGCAGTTTGCAGCTCATATGATTAATA
 GTGTAcGt cGtCAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAGAATTTGCAAGATTACTT
 AGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTATCAGG
 GCATTATGGTGTGGGCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATTCGAA
 ATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACTGTGAATGGTATTAAACGTGGT

SEQUENCE LISTING

ATTTATGACAGTATCAAGTATATGCTCTTTTACA.GATCATTTACACGGAAATACATACGGCCATGCTATTAA
CTTTTACGTGTAGATAAACATAACCCCTAATGC GCCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGAT
CTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGACCCCT
ATAAAAGCCGTTGGAAGTACAAAAGATTATGCC CAAAGAGTAGGCACTGTATCTGATACCTATTGCAGCGAT
CAAAGGAAAAGTAAGCTCATTAGAAAATCGTTT GTCGGCTATTTCATCAAGAAGCTGATATTATGGCAGCCC
AAGCTAAAGTAAGTCAACTTCAAGGTAATTAG CAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAA
GTGAGACAATTAATGATACATAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAACAAGCACA
ACTCGAAGCTACTCGTGTCAATCATTAGCTAA GCTAGCATCGTTGAAAGCCGCACTGCACCAGACAGAAG
CCTTAGCAGAGCAAGCCGAGAGTGACAG CACTGGTGGCTAAAAAGCTCATTGCAATATCTAAGG
GACTTTAAATTGAATCCTAACCGCCTTCAAGT GATACGTGAGCGCATTGATAATCTAAGCAAGATTGGC
TAAACTACCTCATCTTTGTTAAATGCACAAGA AGCTTTAGCAGCCTTACAAGCTTAAACAAAGCAGTTAG
AAGCTACTATTGCTACCACAGAACCAGTTGA CTTTGGCTTAAACCTTAGCTAACGAAAAGGAATATCGC
CACTTAGACGAAGATATAGCTACTGTGCCTGAT TTGCAAGTAGCTCCACCTCTTACGGGCGTAAACCGCT
ATCATATAGTAAGATAGATACTACTCCGCTTGT TCAAGAAATGGTTAAAGAAACGAAACAACCTATTAGAAG
CTTCAGCAAGATTAGCTGCTGAAAATACAAGTC TTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGAAATG
GTAGCAAGTAATGCCATTGTGTCTAAAATCACA TCTTCGATTACTCAGCCCTCATCTAAGACATCTTATGG
CTCAGGATCTTCTACAACGAGCAATCTATTTC TGATGTTGATGAAAGTACTCAACGCTGCTAGCGGTTGGC
GATCCATGGCCTTTAAACACAAGCCAGAGTGTCA GTGCACAAGTTTATAGCAATGAAGGGTATCACCAGCAT
TTGACTGATGAAAAATCACACCTGCAATATAGT AAAGACAACGCACAACCTTCAATTGAGAAATATCTTGA
CGGCTACCAAAATGACCTAGGGAGACACTACTC TAGCTATTATTACTACAACCTAAGAACCGTTATGGGAC
TATCAAGTGAGCAAGACATTGAAAAACACTATGA AGAGCTTAAAGAACAAGTTACATGATATGTACAATCAT
TATgcgccgcactcgagCACCACCACCACCAC

SEQ ID NO: 131 amino acid sequence comprising the 40a-RR-117 fusion construct

M S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q
E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H
L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q I G A E
H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E
T T R A Q D L V E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q
T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A
A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A P
Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K
A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A Q
F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y K
K T H G N T R P S F R Y G Q P G V S G H Y G V G P H D K T I I E D S A G
A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S I K
Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G F S
T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G S T
K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E A D
I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T K
G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L H
Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N R L
Q V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q S
S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T V P
D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L L
E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K I T
S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R A S T G C
G S M A F N T S Q S V S A Q V Y S N E G Y H Q H L T D E K S H L Q Y S K
D N A Q L Q L R N I L D G Y Q N D L G R H Y S S Y Y Y N L R T V M G L
S S E Q D I E K H Y E E L K N K L H D M Y N H Y A A A L E H H H H H

SEQ ID NO: 132 polynucleotide sequence comprising fusion construct GAS 117 - 40a

ATGGCCTTTAAACACAAGCCAGAGTGTCAAGTGCAC.AAGTTTATAGCAATGAAGGGTATCACCAGCATTGAC
TGATGAAAAATCACACCTGCAATATAGTAAAGAC.AACGCACAACCTCAATTGAGAAATATCCTTGACGGCT
ACCAAAATGACCTAGGGAGACACTACTCTAGCTA.TTATTACTACAACCTAAGAACGTTATGGGACTATCA
AGTGAGCAAGACATTGAAAAACACTATGAAGAGC.TTAAAGAACAAGTTACATGATATGTACAATCATTATGc

SEQUENCE LISTING

ATGAGTGTAGGCGTATCTACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAA
CGAAGGCGAGTAATACTCACGACGATAGTTTACCAAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATP
GATGCAGTTGAAAAAAGTCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAAAC
TACTGCTGAAATCAACCACATAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAA
TTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTA
ACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTGAGAACA
AAAAGCTAGCATTTCAGCAGAAACTACTCGAGCTCAAGATTTAGTGGAAACAAGTCAAACCGTCTGAACAAA
ATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACATAAGCAGCTCAAACGGCTAATGAT
AATACAAAAGCATTAAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGAGCTAAAGTTAA
AAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCTGCT
TTAAATCCTCAGCTCCGTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTAT
CCTCTTGAAGAACTTAAAAAATTAGAAGCTAGTGGTTATATTTGGATCAGCTAGTTACAATAATTATTACAA
AGAGCATGCAGATCAAATTATTGCCAAAGCTAGTCCAGTAAATCAATTAATCAATACCAAGATATTCAG
CAGATCGTAATCGCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAATGGCTAGCGCAGTTTGCA
GCTCACATGATTAATAGTGTAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAGA
ATTTGCAAGATTACTTAGTAC CAGCTATAAGAAAACCTCATGGTAATACAAGACCATCATTTGTCTACGGAC
AGCCAGGGGTATCAGGCATTATGGTGTGGGCCCTCATGATAAAACTATTATTGAAGACTCTGCCGGAGCG
TCAGGGCTCATTGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATAACTGTGAA
TGGTATTAACCGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTACACGGAATACAT
ACGGCCATGCTATTAACCTTTTACGTGTAGATAAAACATAACCCCTAATGCGCCTGTTTACCTTGGATTTTCA
ACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACG
CTTTAATAAGACCCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCATGTATCTG
ATACTATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGGCTATTTCATCAAGAAGCT
GATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAATTTAGCAAGCACACTTAAGCAGTCAGA
CAGCTTAAATCTCCAAGTGTAGACAATTAATGATACTAAAGGTTCTTTGAGAACAGAATTAAGTACGAGCTA
AAGCAAAAACAAGCACAACCTGAAGCTACTCGTACTCATAGCTAAGCTAAGCTAGCATCGTTGAAAGCCGCA
CTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGACAGAGTACAGCAGCACTGGTGGCTAAAAAGACTCA
TTTGCAATATCTAAGGGACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATA
CTAAGCAAGATTTGGCTAAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCT
AAACAAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAAACCTTAGCTAA
CGAAAAGGAATATCGCCACTTAGACGAAGATATAGCTACTGTGCCCTGATTTGCAAGTAGCTCCACCTCTTA
CGGGCGTAAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAAATGGTTAAAGAAACG
AAACAACCTATTAGAAGCTTACGCAAGATTAGCTGCTGAAAATACAAGTCTTTGTAGCAGAAGCGCTTGTGG
CCAAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCAT
CTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTCTGATGTTGATGAAAGTACTCAA
cGtgcgccgactcgagCACCACCACCACCAC

SEQ ID NO: 133 amino acid sequence comprising fusion construct GAS 117-40a

M A F N T S Q S V S A Q V Y S N E G Y H Q H L T D E K S H L Q Y S K D N
A Q L Q L R N I L D G Y Q N D L G R H Y S S Y Y Y N L R T V M G L S S
E Q D I E K H Y E E L K N K L H D M Y N H Y A S G G G S M S V G V S H Q
V K A D D R A S G E T K A S N T H D D S L P K P E T I Q E A K A T I D A
V E K T L S Q Q E I Y T N T L A S S E T L L A Q G A E H Q R E L T A T
Q K A L T S A Q E I Y T N T L A S S E T L L A Q G A E H Q R E L T A T
E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E T R A Q D L V
E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q T A N D N T K A
L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A A Q K A A L A E
K E A E L S R L K S S A P S T Q D S I V G N N T M K A P Q G Y P L E E L
K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K A S P G N Q L N
Q Y Q D I P A D R N R F V D P D N L T P E V Q N G L A Q F A A H M I N S
V R R Q L G L P V T V T A G S Q E F A R L L S T S Y K K T H G N T R P
S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A G A S G L I R N D
D N M Y E N I G A F N D V H T V N G I K R G I Y D S I K Y M L F T D H L
H G N T Y G H A I N F L R V D K H N P N A P V Y L G F S T S N V G S L N
E H F V M F P E S N I A N H Q R F N K T P I K A V G S T K D Y A Q R V G
T V S D T I A A I K G K V S S L E N R L S A I H Q E A D I M A A Q A K V

SEQUENCE LISTING

S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T K G S L R T E L L
A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L H Q T E A L A E Q
A A A R V T A L V A K K A H L Q Y L R D F K L N P N R L Q V I R E R I D
N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q S S L E A T I A T
T E H Q L T L L K T L A N E K E Y R H L D E D I A T V P D L Q V A P P L
T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L L E A S A R L A A
E N T S L V A E A L V G Q T S E M V A S N A I V S K I T S S I T Q P S S
K T S Y G S G S S S T T S N L I S D V D E S T Q R A A A L E H H H H H

SEQ ID NO: 134 polynucleotide sequence comprising fusion construct GAS 117-40N

ATGGCCTTTAACACAAGCCAGAGTGTCAAGTTCAGTGCACAAGTTTATAGCAATGAAGGGTATCACCAGCATTGAC
TGATGAAAAATCACACCTGCAATATAGTAAAGACAACGCACAACCTTCAATTGAGAAATATCCTTGACGGCT
ACCAAATGACCTAGGGAGACACTACTCTAGCTATTATTACTACAACCTAAGAACCCTTATGGGACTATCA
AGTGAGCAAGACATTGAAAAACACTATGAAGAGCTTAAGAACAAGTTACATGATATGTACAATCATTATG
tagcggtagcggatccatgagtgtagggctatctcaccaagtcAAAGCAGATGATAGAGCCTCAGGAGAAA
CGAAGGCGAGTAATACTCAGCAGCATAGTTTACCAAAACCAGAAACAATTCAGAGGGCAAAGGCAACTATT
GATGCAGTTGAAAAACTCTCAGTCAACAAGAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAAAC
TACTGCTGAAATCAACCACCTTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTTGACAAAGAAA
TTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTA
ACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTCAGAACA
AAAAGCTAGCATTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGAACAAGTCAAACCGTCTGAACAAA
ATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGAT
AATACAAAAGCATTAAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAA
AAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTC
TTAAATCCTCAGCTCCGCTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTAT
CCTCTTGAAGAATTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAA
AGAGCATGCAGATCAAATTTATGCAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGcggccgcac
tcgagCACCACCACCACCAC

SEQ ID NO: 135

M A F N T S Q S V S A Q V Y S N E G Y H Q H L T D E K S H L Q Y S K D N
A Q L Q L R N I L D G Y Q N D L G R H Y S S Y Y Y N L R T V M G L S S
E Q D I E K H Y E E L K N K L H D M Y N H Y A S G G G S M S V G V S H Q
V K A D D R A S G E T K A S N T H D D S L P K P E T I Q E A K A T I D A
V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H L K E Q Q D N E
Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E H Q R E L T A T
E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E T T R A Q D L V
E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q T A N D N T K A
L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A A Q K A A L A E
K E A E L S R L K S S A P S T Q D S I V G N N T M K A P Q G Y P L E E L
K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K A S P G N Q L N
Q Y Q A A A L E H H H H H H

SEQ ID NO: 136

AGTTGGTA